

2 101.11:5-3805-201-15

# **TM 5-3805-201-15**

**DEPARTMENT OF THE ARMY TECHNICAL MANUAL**

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**OPERATOR,  
ORGANIZATIONAL, FIELD AND DEPOT  
MAINTENANCE MANUAL**

**LOADER, SCOOP TYPE:  
DIESEL ENGINE; 4 WHEEL DRIVE,  
REAR WHEEL STEERABLE PNEUMATIC TIRES:  
2½ CU YD; W/MULTI-SEGMENT BUCKET  
(FRANK G. HOUGH MODEL H-90CM)  
FSN 3805-995-3236**

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This copy is a reprint which includes current  
pages from Changes 2 through 6.

**HEADQUARTERS, DEPARTMENT OF THE ARMY  
FEBRUARY 1964**

## SAFETY PRECAUTIONS

### BEFORE OPERATION

*Check Loader Before Starting.* Walk around the loader before starting to make sure no one is in a danger area around the loader. Sound the horn before moving the loader. Before starting, make sure all operating levers are in neutral or off position. Never attempt to move the loader while the low air pressure buzzer is sounding, or until the air pressure gage indicates between 85 and 105 psi.

*Stop Machine Before Lubricating or Adjusting.* Shut off the engine before performing any cleaning, adjusting, or lubrication of the loader.

*Keep Tires Inflated Properly.* Check tire pressure at least once a week to insure proper operation and long tire life.

### DURING OPERATION

*Mount and Dismount Loader on Left Side Only.* Always mount and dismount the loader on the left side, using the ladder provided to avoid falls and accidental movement of the operating controls. Never get on or off while the loader is in motion.

*Operate Loader in Proper Speed Range.* Select an operating speed that is safe for the particular job. Reduce speed when roads are wet or icy. The maximum rated speed of this loader is 28 mph. Never exceed this rated speed.

*Watch Bucket During Operation.* Watch the load during hoisting, lowering, and dumping operations.

*Face Direction of Travel.* Always face the direction of travel when the loader is in motion.

*Do Not Carry Passengers.* Do not carry passengers in the bucket, on the sides of the machine, or on the loader in any other manner.

*Never Hoist Bucket Over Personnel.* Use extra caution when working with a ground crew. Do not allow anyone to get under a raised bucket. Never raise the bucket over the cab of a truck. Approach a truck from the back or from the sides.

*Lower Bucket When Traveling With Loader.* Greatest loader stability and better visibility are achieved when the load is carried close to the ground. The best bucket traveling height is 12 inches. Tip the bucket to the rear when traveling.

*Disengage Rear Axle When Traveling Loader.* When traveling the loader for long distances or when operating the loader on a hard surfaced road, disengage the rear axle to increase tire life. Engage the rear axle to gain additional traction particularly when operating on soft or slippery terrain.

*Do Not Use Bucket For Braking.* Do not skid the bucket to assist braking, even when traveling down steep inclines. This causes unnecessary bucket wear and places an undue strain on the boom and bucket parts when bumps or rocks are encountered.

*Keep Operating Controls and Decks Clean.* Keep hands and operating controls free from grease, water, and mud to insure positive movement of the controls. Keep decks free of oil and grease to minimize the danger of slipping.

*Do Not Exceed Rated Capacity.* The rated capacity of the loader is  $2\frac{1}{2}$  cubic yards. Do not overload this machine. Watch the load at all times during operation.

*Do Not Operate With Overheated Torque Converter.* If the torque converter temperature warning light should light up, it indicates that the torque converter oil is overheated. Shift to neutral and operate the engine at a fast idle until the torque converter oil temperature decreases to less than 250° F.

### AFTER OPERATION

Observe all precautions listed in the maintenance and repair sections of the manual.

*Maintain Proper Brake Adjustment.* Adjust brakes immediately when brake slippage is noted.

*Shut Off Engine Before Leaving Machine.* Never leave the machine unattended with the engine running. Lower the bucket to the ground, place the directional shift lever in neutral, set the parking brake, and shut down the engine before leaving the operator's seat.

*Lower Boom Before Leaving Machine.* Do not leave the machine with the bucket in the air. Accidental lowering of the boom could cause severe injury to personnel.

*Apply Parking Brake When Parking Loader.* Apply the parking brake on the loader when parking or any time when leaving the operator's seat. Block the wheels when parking on a grade.



Change }  
No. 6 }

DEPARTMENTS OF THE ARMY  
AND THE AIR FORCE  
Washington, D.C., 25 September 1973

**Operator, Organizational, Direct Support,  
General Support, and Depot Maintenance Manual  
LOADER, SCOOP TYPE: DIESEL ENGINE; 4 WHEEL DRIVE,  
REAR WHEEL STEERABLE PNEUMATIC TIRES:  
2 1/2 CU. YD. W/MULTI-SEGMENT BUCKET  
(FRANK G. HOUGH MODEL H-90CM)  
FSN 3805-995-3236**

TM 5-3805-201-15, 24 February 1964 is changed as follows:

Page 4. Paragraph 2c, the mailing address is changed to read "Commander, US Army Troop Support Command, ATTN: AMSTS-MPP, St. Louis, MO 63120".

Page 58. Paragraph 127 Subparagraph *d* is added as follows:

*d.* An aneroid control is provided in the fuel system to help regulate the fuel pressure in accordance with the amount of air being introduced into the engine intake manifold by the turbocharger. It uses manifold air pressure to regulate the amount of fuel bypass from the outlet side of the pump to the inlet side of the pump in order to maintain an efficient fuel-to-air ratio.

Page 71. Paragraph 135. Subparagraphs *d* through *i* are added as follows:

*d. Servicing.*

(1) Each 200 hours of operation remove the air filter cap (15, fig. 64.1), spring (14), air filter (13), and air filter body (12) from

the aneroid control (6); remove the drain plug (8) and allow the oil to drain.

(2) Wash the air filter parts in cleaning solvent; dry with compressed air.

(3) Install the drain plug on the aneroid control; fill the aneroid control with the same grade oil as used in the engine crankcase (capacity 3 ounces).

(4) Install the air filter body (12) on the aneroid control; position the air filter, spring, and cap on the air filter body.

*e. Removal (fig. 46.1).*

(1) Disconnect the hoses (10) from the elbows (11) and from the adapter (9). Catch the fuel that drains in a suitable container. Remove the hoses, elbows, and adapters.

(2) Disconnect the air supply hose (2) from the elbow (1) at the intake manifold and from the top of the aneroid control. Remove the air supply hose and the elbow.

(3) Remove the two screws (7) and lockwashers (5) that secure the aneroid control to the bracket (3). Remove the aneroid control.

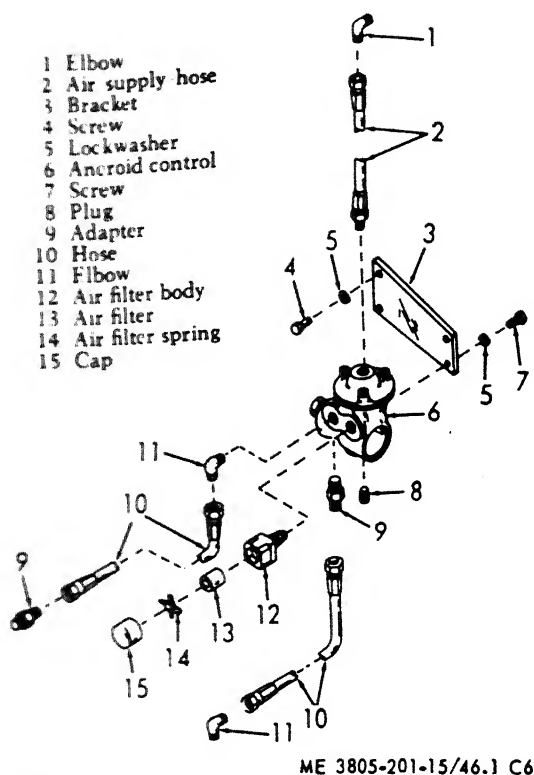


Figure 46.1 Aneroid control mounting parts, exploded view.

*f. Disassembly (fig. 46.2)*

(1) Remove the three screws (2), lockwasher (3) and flatwasher (4) that secure the cover (1) to the aneroid control housing. Remove the cover.

(2) Remove the nut (6) and bellows retainer washer (7) that secure the bellows (5) to the actuating shaft (10). Remove the bellows, bellows piston (8), spring (9), and shims (11) from the housing.

(3) Remove the spring retainer (19) from the side of the aneroid control housing. Remove the spring (21), washer (22), and pressure plunger (23) from the housing. Remove the preformed packing (20) from the spring retainer.

(4) Loosen the nut (6) on the adjusting screw (16). Remove the adjusting screw, *noting the number of turns from the housing.*

Remove the nut and non-metallic washer (17) from the adjusting screw.

(5) Remove the cover (13) from the housing. Remove the lever pin and valve assembly (14) and actuating shaft (10) from the housing. Remove the preformed packing (12) from the lever pin and valve assembly.

- 1 Cover
- 2 Screw
- 3 Lockwasher
- 4 Flatwasher
- 5 Bellows
- 6 Nut
- 7 Bellows retainer
- 8 Bellows piston
- 9 Bellows spring
- 10 Actuating shaft
- 11 Shim
- 12 Preformed packing
- 13 Cover
- 14 Lever pin and valve assembly
- 15 Plug
- 16 Adjusting screw
- 17 Non-metallic washer
- 18 Plug
- 19 Spring retainer
- 20 Preformed packing
- 21 Spring
- 22 Non-metallic washer
- 23 Pressure plunger
- 24 Housing

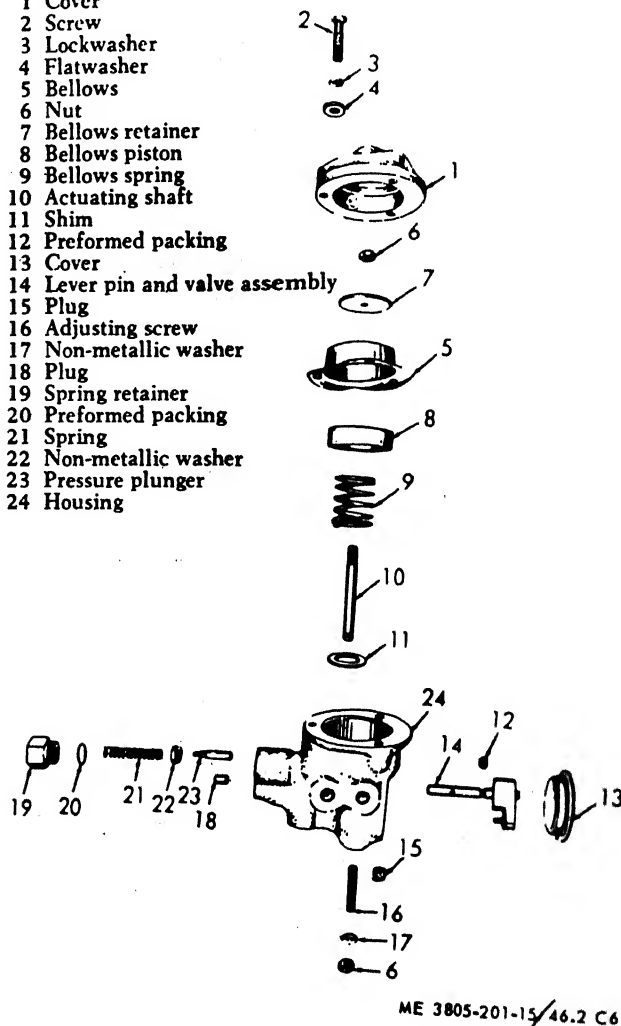


Figure 46.2 Aneroid control, exploded view

*g. Cleaning and Inspection.*

(1) Clean all the metal parts of the aneroid control with cleaning solvent; dry thoroughly. Wipe all dirt from the bellows with a dry cloth.

(2) Inspect the bellows for cracks, tears, deterioration, or wear.

(3) Inspect the springs for distortion and loss of tension.

(4) Inspect the lever pin and valve assembly and pressure plunger for scoring or signs of wear.

(5) Inspect the remaining parts for cracks, stripped threads, or other damage; replace all unserviceable parts.

*h. Reassembly (see fig. 46.2).*

(1) Position the preformed packing (12) on the lever pin and valve assembly (14). Position the actuating shaft (10) and the lever pin and valve assembly, with the pin engaging the hole of the actuating shaft, in the housing (24), install the cover (13).

(2) Install the adjusting screw (16) on the housing, turning it the number of turns as noted at disassembly. Secure with the non-metallic washer (17) and nut (6).

(3) Position the preformed packing (20) on the spring retainer (19). Position the pressure plunger (23), non-metallic washer, and spring (21) in the housing. Secure with the spring retainer.

(4) Position the shims (11) and bellows spring (9) in the housing. Pull the actuating shaft to the top of its travel and measure the distance the shoulder of the shaft is below the top of the spring. The correct distance is 3/32-inch. If the distance is more than 3/32-inch,

position a 1/4-inch internal diameter flat washer of proper thickness to make the distance correct on the actuating shaft. If less than 3/32 inch, install additional shims under the spring to make the correct distance.

#### NOTE

If the shims fill the spring counter-bore of the housing, check for a wrong bellows spring.

(5) Position the bellows piston (8) in the bellows (5). Position the bellows and piston on the actuating shaft so the holes are aligned with the housing. Secure with the bellows retainer washer (7) and nut (6).

(6) Position the cover (1) on the housing so the holes are aligned. Secure with three screws (2), lockwashers (3), and flatwashers (4).

*i. Installation (see fig. 46.1).*

(1) Position the aneroid control on the bracket (3). Secure with two screws (7) and lockwashers (5).

(2) Install the elbow (1) on the intake manifold. Connect the arm supply hose (2) to the top of the aneroid control and to the elbow on the intake manifold.

(3) Install the elbows and the adapters (9) in the fuel pump and the aneroid control. Connect the hoses (10) to the adapters and to the elbows.

By Order of the Secretaries of the Army and the Air Force:

Official:

VERNE L. BOWERS  
Major General, United States Army  
The Adjutant General

Official:

JACK R. BENSON, Colonel, USAF  
Director of Administration

CREIGHTON W. ABRAMS  
General, United States Army  
Chief of Staff

GEORGE S. BROWN, General, USAF  
Chief of Staff

Distribution:

To be distributed in accordance with DA Form 12-25B (qty rqr block No. 402) organizational maintenance requirements for Earth Moving Equipment, Loaders.

Changes in force: C 2, C 3, C 4 and C 5

TM 5-3805-201-15  
C 5

CHANGE }

No. 5

HEADQUARTERS  
DEPARTMENT OF THE ARMY  
Washington, D.C. 18 August 1970

Operator, Organizational, Direct Support,  
General Support and Depot Maintenance Manual  
LOADER, SCOOP TYPE: DIESEL ENGINE; 4 WHEEL DRIVE; REAR WHEEL  
STEERABLE; PNEUMATIC TIRES; 2½ CU YD; W/MULTI-SEGMENT BUCKET  
(FRANK G. HOUGH MODEL H-90CM) FSN 3805-995-3236

TM 5-3805-201-15, 24 February 1964, is changed  
as follows:

Page 138. Paragraph 212d, "Shut down engine."  
is added after second sentence.

Page 178. Paragraph 237a, the following is added  
to the general paragraph:

a.1 Tools Required

- (1) Splined wrench adapter, FSN 5120-672-7498
- (2) Injector holding fixture, FSN 5120-364-5417
- (3) Spot-facing tool, FSN 5120-766-4754
- (4) Seat checking tool, FSN 5120-690-7951."

By Order of the Secretary of the Army:

Official:

KENNETH G. WICKHAM,  
Major General, United States Army,  
The Adjutant General.

W. C. WESTMORELAND,  
General, United States Army,  
Chief of Staff.

Distribution:

To be distributed in accordance with DA Form 12-25, Sec II (qty rqr Block No. 402), Organizational maintenance requirements for Earth  
Moving Equipment: Loaders.

Changes in Force: C 2, C 3, and C 4

TM 5-3805-201-15  
C 4

CHANGE }  
No. 4 }

HEADQUARTERS  
DEPARTMENT OF THE ARMY  
WASHINGTON, D. C., 5 January 1970

**Operator, Organizational, Direct Support,  
General Support, and Depot Maintenance Manual**

**LOADER, SCOOP TYPE: DIESEL ENGINE; 4 WHEEL DRIVE,  
REAR WHEEL STEERABLE PNEUMATIC TIRES:  
2½ CU. YD. W/MULTI-SEGMENT BUCKET  
(FRANK G. HOUGH MODEL H-90CM)  
FSN 3805-995-3236**

TM 5-3805-201-15, 24 Februzry 1964, is changed as follows:

*Cover and Title pages.* Nomenclature is changed as indicated above.

*Page 4.* Paragraph 1b, the last sentence is superseded as follows:

Repair parts are contained in TM 5-3805-201-20P.

*Page 4.* Paragraph 1c is rescinded.

*Page 4.* Paragraph 2 is superseded as follows:

**2. Forms and Records**

a. Maintenance forms, records, and reports which are to be used by maintenance personnel at all maintenance levels are listed in and prescribed by TM 38-750.

b. Report of errors, omissions, and recommendations for improving this publication by the individual user is encouraged. Reports should be submitted on DA Form 2028, Recommended

Changes to DA Publications, and forwarded direct to the Commanding General, U. S. Army Mobility Equipment Command, ATTN: AMSME-MPP, 4300 Goodfellow Boulevard, St. Louis, Mo. 63120.

*Page 72.* Paragraph 137a, Note, add to the end of the last sentence:

Refer to TM 9-6140-200-15.

*Page 292.* Section II, 0100 Engine, (Replace), in column 4 of Echelons of Maintenance, delete the "X" and add the "X" to column 3.

*Page 293.* Section II, 0106, Oil Cooler, (Repair), is changed to read: Replace.

*Page 294.* Section II, 0501 Radiator (Replace), in column 3 of Echelons of Maintenance, delete the "X" and add the "X" to column 2.

*Pages 302 thru 306.* Appendix III is superseded as follows:

## APPENDIX III

### BASIC ISSUE ITEMS LIST

#### Section I. INTRODUCTION

##### 1. Scope

This appendix lists items which accompany the scoop type loader or are required for installation, operation, or operator's maintenance.

##### 2. General

This Basic Issue Items List is divided into the following sections:

a. Basic Issue Items—Section II. A list of items which accompany the scoop type loader and are required by the operator/crew for installation, operation, or maintenance.

b. Maintenance and Operating Supplies—Section III. A listing of maintenance and operating supplies required for initial operation.

##### 3. Explanation of Columns

The following provides an explanation of columns in the tabular list of Basic Issue Items, Section II.

a. *Source, Maintenance, and Recoverability Codes (SMR).*

(1) Source code, indicates the source for the listed item. Source codes are:

Code	Explanation
P....	Repair parts which are stocked in or supplied from the GSA/DSA or Army supply system, and authorized for use at indicated maintenance categories.
M....	Repair parts which are not procured or stocked, but are to be manufactured at indicated maintenance levels.
A....	Assemblies which are not procured or stocked as such, but are made up of two or more units. Such component units carry individual stock numbers and descriptions, are procured and stocked separately and can be assembled to form the required assembly at indicated maintenance categories.
X....	Parts and assemblies which are not procured or stocked and the mortality of which normally is below that of the applicable end item or component. The failure of such part or assembly should result in retirement of the end item from the supply system.
X1....	Repair parts which are not procured or stocked. The requirement of such items will be filled by use of the next higher assembly or component.
X2....	Repair parts which are not stocked. The indicated maintenance category requiring such repair parts will attempt to obtain them through cannibalization. Where such repair parts are not obtainable through cannibalization, requirements will be

Code

Explanation

requisitioned, with accompanying justification, through normal supply channels.

G.... Major assemblies that are procured with PEMA funds for initial issue only as exchange assemblies at DSU and GSU level. These assemblies will not be stocked above GS and DS level or returned to depot supply level.

(2) Maintenance code, indicates the lowest category of maintenance authorized to install the listed item. The maintenance level code is:

Code

Explanation

C.... Operator/crew

(3) Recoverability code, indicates whether unserviceable items should be returned for recovery or salvage, Items not coded are expendable. Recoverability codes are:

Code

Explanation

R.... Repair parts (assemblies and components) which are considered economically repairable at direct and general support maintenance levels. When the maintenance capability to repair these items does not exist, they are normally disposed of at the GS level. When supply considerations dictate, some of these repair parts may be listed for automatic return to supply for depot level repair as set forth in AR 710-50. When so listed, they will be replaced by supply on an exchange basis.

S.... Repair parts and assemblies which are economically repairable at DSU and GSU activities and which normally are furnished by supply on an exchange basis. When items are determined by a GSU to be uneconomically repairable they will be evacuated to a depot for evaluation and analysis before final disposition.

T.... High dollar value recoverable repair parts which are subject to special handling and are issued on an exchange basis. Such repair parts normally are repaired or overhauled at depot maintenance activities.

Repair parts specifically selected for salvage by reclamation units because of precious metal content, critical materials, or high dollar value reusable casings or casting.

b. *Federal Stock Number.* This column indicates the Federal stock number assigned to the item and will be used for requisitioning purposes.

c. *Description.* This column indicates the Federal item name and additional description of the item required. The abbreviation "w/e," when

used as a part of the nomenclature, indicates the Federal stock number, includes all armament, equipment, accessories, and repair parts issued with the item. A part number or other reference number is followed by the applicable five-digit Federal supply code for manufacturers in parenthesis. Repair parts quantities included in kits, sets, and assemblies are shown in front of the repair part name.

d. *Unit of Measure (U/M)*. A 2 character alphabetic abbreviation indicating the amount or quantity of the item upon which the allowances are based, e.g., ft, ea, pr, etc.

e. *Quantity Incorporated in Unit*. This column indicates the quantity of the item used in the assembly group. A "V" appearing in this column in lieu of a quantity indicates that a definite quantity cannot be indicated (e.g. shims, spacers, etc.).

f. *Quantity Furnished With Equipment*. This column indicates the quantity of an item furnished with the equipment.

g. *Illustration*. This column is divided as follows:

(1) *Figure Number*. Indicates the figure number of the illustration in which the item is shown.

(2) *Item Number*. Indicates the callout number used to reference the item in the illustration.

#### 4. Explanation of Columns in the Tabular List of Maintenance and Operating Supplies—Section III

a. *Component Application*. This column identifies the component application of each maintenance or operating supply item.

b. *Federal Stock Number*. This column indicates the Federal stock number assigned to the item and will be used for requisitioning purposes.

c. *Description*. This column indicates the item name and brief description.

d. *Quantity Required for Initial Operation*. This column indicates the quantity of each maintenance or operating supply item required for initial operation of the equipment.

e. *Quantity Required for 8 Hours Operation*. This column indicates the estimated quantities required for an average 8 hours of operation.

f. *Notes*. This column indicates informative notes keyed to data appearing in a preceding column.

### SECTION II. BASIC ISSUE ITEMS

(1) SMR code	(2) Federal stock number	(3) Description		(4) Unit of meas	(5) Qty inc in unit	(6) Qty furn with equip	(7) Illustration	
		Ref No. & mfr code	Usable on code				(A) Fig No.	(B) Item No.
		BASIC ISSUE ITEMS, MANUFACTURER OR DEPOT INSTALLED						
PC	7510-889-3494	BINDER, LOOSELEAF.....		EA		1		
PC	7520-559-9618	CASE, MAINTENANCE AND OPERATION MANUALS DA TECHNICAL MANUAL TM 5-3805-201-15.....		EA EA		1 1		
		BASIC ISSUE ITEMS, TROOP INSTALLED						
PC	4210-889-2221	EXTINGUISHER, FIRE, 2½ LB. FED. SPEC. 0-E95.....		EA		1		

# SECTION III. MAINTENANCE AND OPERATING SUPPLIES

(1) Component application	(2) Federal stock number	(3) Description	(4) Quantity required initial operation	(5) Quantity required 1/8 hrs operation	(6) Notes
CRANKCASE (1)	9150-265-9435(2) 9150-265-9428(2) 9150-242-7603(2)	OIL, LUBRICATING: 5 gal pail as follows OE-30..... OE-10..... OES.....	19 qt 19 qt 19 qt	(3) (3) (3)	(1) Includes quantity of oil to fill engine oil system as follows; 19 qt. crankcase.
FUEL TANK	9140-286-5294(2) 9140-286-5286(2) 9140-286-5283(2) 2910-355-6377	FUEL OIL, DIESEL: Bulk as follows: Regular grade DF-2..... Winter grade DF-1..... Artic grade DF-A..... CAPSULE, STARTING.....	55 gal (4) 55 gal (4) 55 gal (4) 1 (6)	(5) (5) (5)	(2) See SM-C9100-IL for additional data and requisitioning procedure.
ENGINE STARTING AID	6850-243-1992 6850-174-1806	WATER..... ANTIFREEZE: Ethylene glycol 1 - gal can..... ANTIFREEZE: Artic, 55 gal drum..... OIL, LUBRICATING: (8) OE 10..... OES.....	32 qt (7) 21 qt 32 qt (7) 21 qt 21 qt	(3) (3)	(3) See current LO for grade application and replenishment intervals.
RADIATOR		LUBRICATING OIL: Gear, 5 gal pail as follows			(4) Tank capacity.
TRANSMISSION, CONVERTER, AND COOLER	9150-577-5847(2) 9150-577-5844(2) 9150-257-5440(2)	GO 140..... GO 90..... GOS.....	53 3/4 qt 53 3/4 qt 53 3/4 qt	(3) (3) (3)	(5) Average fuel consumption is 3 3/4 gal per hour of continuous operation.
DIFFERENTIAL ASSEMBLY, REAR		LUBRICATING OIL: Gear (9) GO 140..... GO 90.....	2 5/8 qt ea (10) 2 5/8 qt ea (10)	(3) (3)	(6) Quantity indicated is the minimum required for one start when temperature is below 40°F.
FRONT PLANETARY		GOS..... LUBRICATING OIL: Gear (9) GO 140..... GO 90.....	2 5/8 qt ea (10) 2 5/8 qt ea (10)	(3) (3)	(7) Radiator capacity.
DIFFERENTIAL ASSEMBLY, REAR		GOS..... LUBRICATING OIL: Gear (9) GO 140..... GO 90.....	2 5/8 qt ea (10) 2 5/8 qt ea (10)	(3) (3)	(8) Use oil as prescribed under crankcase above.
REAR PLANETARY		GOS..... LUBRICATING OIL: Gear (9) GO 140..... GO 90.....	2 5/8 qt ea (10) 2 5/8 qt ea (10)	(3) (3)	(9) Includes quantity of gear lubricating oil as follows: 22 1/2 qt front differential 20 1/2 qt rear differential 2 5/8 qt rear planetary (ea) 1/4 qt steering gear
HYDRAULIC BRAKE SYSTEM	9150-252-6375(2)	GO 140..... GO 90..... GOS..... BRAKE FLUID, AUTOMOTIVE: 1 - gal can HBA.....	2 5/8 qt ea (10) 2 5/8 qt ea (10) 2 5/8 qt ea (10) 3/4 qt	(3) (3) (3)	(10) Use lubricating oil as prescribed in item 9.



(1) Component application	(2) Federal stock number	(3) Description	(4) Quantity required l/initial operation	(5) Quantity required l/8 hrs operation	(6) Notes
STEERING GEAR (9)		LUBRICATING OIL: Gear, 5-gal pail as follows: GO 140..... GO 90..... GOS.....	1/4 qt (10) 1/4 qt (10) 1/4 qt (10)	(3) (3) (3)	
HYDRAULIC SYSTEM		OIL, LUBRICATING: 5-gal pail as follows: OE 10..... OES.....	58 qt (8) 58 qt (8)	(3) (3)	
GREASE POINTS	9150-190-0905(2)	GREASE, AUTOMOTIVE AND ARTIL- LERY: 5-lb can as follows: GAA.....	5 lb.	(3)	

By Order of the Secretary of the Army:

Official:

KENNETH G. WICKHAM,  
*Major General, United States Army,  
The Adjutant General.*

W. C. WESTMORELAND,  
*General, United States Army,  
Chief of Staff.*

Distribution:

To be distributed in accordance with DA Form 12-25, Section II (qty rqr block no. 402) organizational maintenance requirements for Earth Moving Equipment: Loaders.

**\*TM 5-3805-201-15**  
**C 3**

CHANGE }  
No. 3 }

HEADQUARTERS  
DEPARTMENT OF THE ARMY  
WASHINGTON, D. C., 3 November 1967

**Operator, Organizational, Field  
and Depot Maintenance Manual**

**LOADER, SCOOP TYPE: DIESEL ENGINE: 4 WHEEL DRIVE,**

**REAR WHEEL STEERABLE PNEUMATIC TIRES:**

**2 1/2 CU YD; W/MULTI-SEGMENT BUCKET**

**(FRANK G HOUGH, MODEL H-90CM)**

**FSN 3805-995-3236**

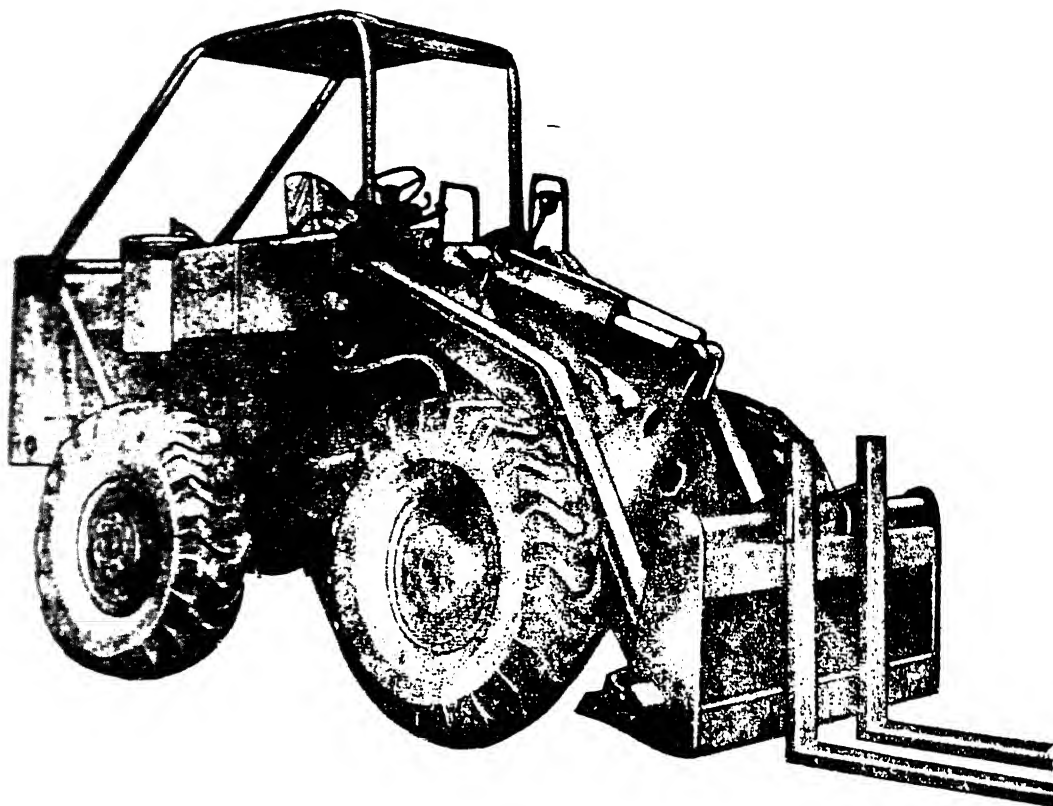
TM 5-3805-201-15, 24 February 1964, is changed as follows: Inside cover page. Add the following below "DURING OPERATION"

Before disconnecting and hydraulic lines, rest fork lift or bucket on ground, place all controls in neutral position, and remove filler cap from hydraulic oil reservoir.

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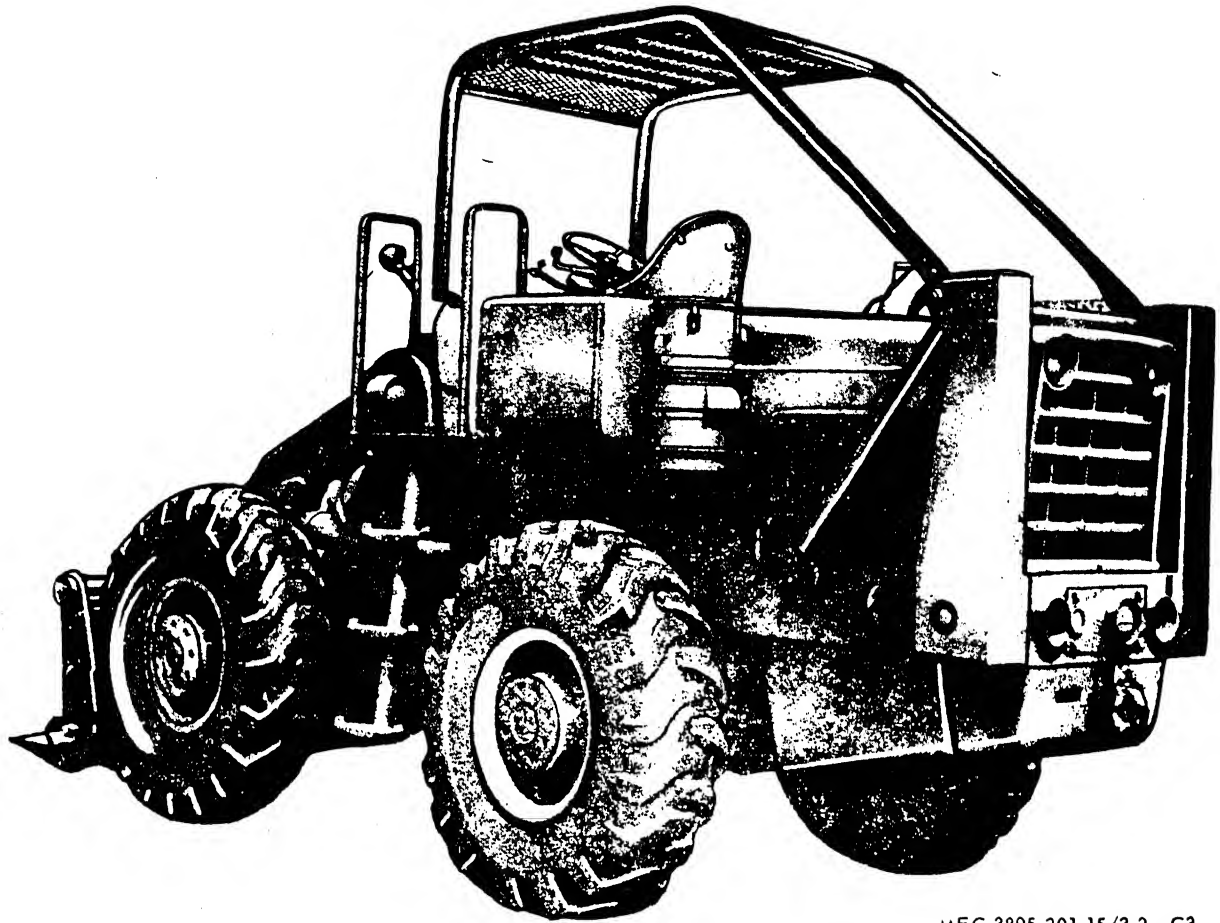
\* This change supersedes C 1, 13 December 1965.

Page 3 Following figure 3. add:



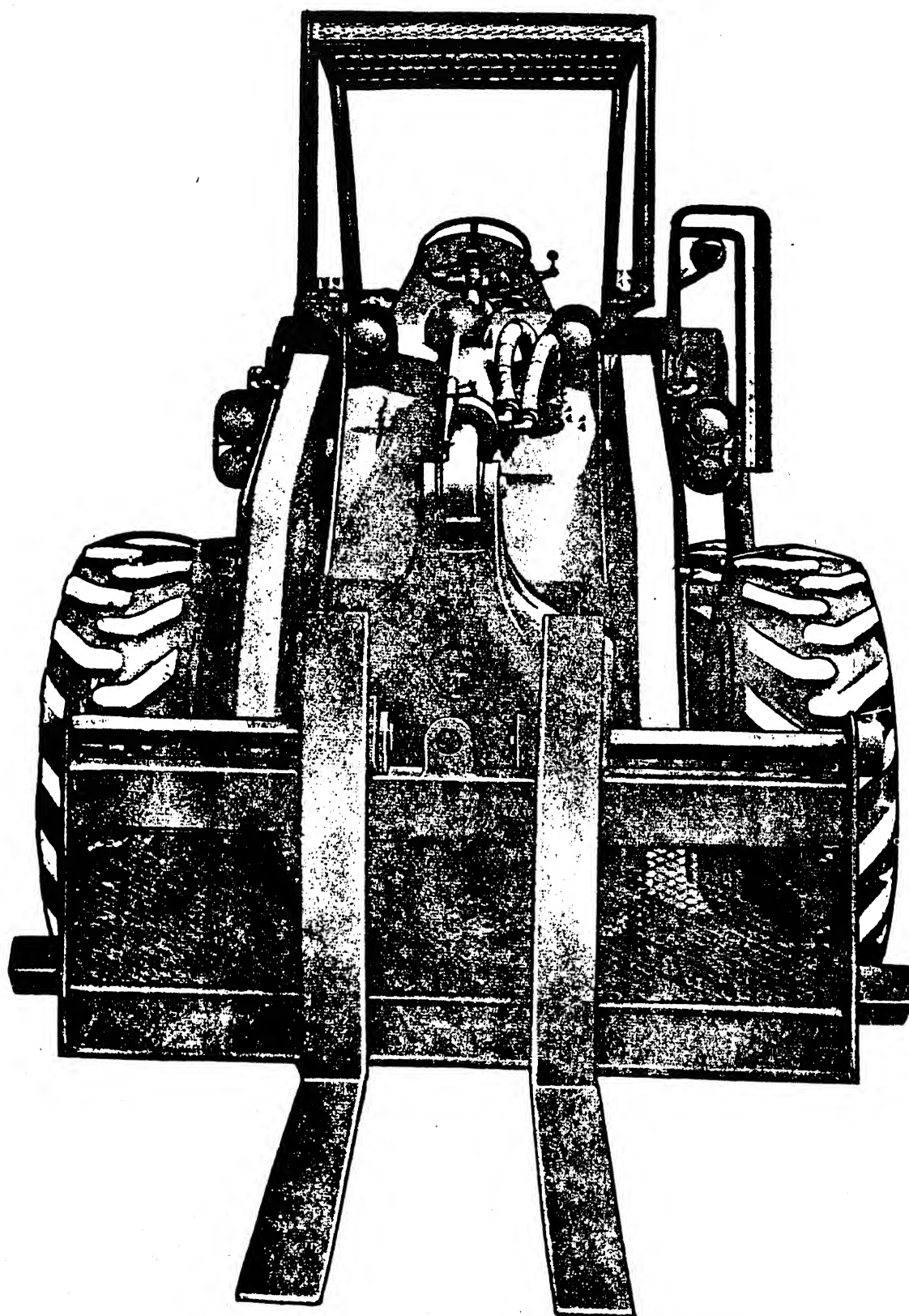
MEC 3805-201-15/3.1 C3

Figure 3.1 Loader, fork lift model, front three quarter view. (Serial nos. 27MC-1778 through 27MC-1927)



MEC 3805-201-15/3.2 C3

*Figure 3.2. Loader, fork lift model, rear three quarter view. (Serial nos. 27MC-1788 through 27MC-1927.)*



MEC 3805-201-15/3.3 C3

*Figure 3.3. Loader, fork lift model, front view. (Serial nos. 27MC-1778 through 27MC-1927)*

Page 4. Pararaph 1c is superseded as follows:

c. DA Form 2028 (Recommended Changes to DA Publications) will be used for reporting discrepancies and recommendations for improving this equipment publication. This form will be completed by the individual using the manual and forwarded direct to Commanding General, U.S. Army Mobility Equipment Command, ATTN: AMSME-MPP, 4300 Goodfellow Blvd., St. Louis, Mo. 63120.

Paragraph 3a is superseded as follows:

a. General.

- (1) The Model H-90CM loader is manufactured by the Frank G. Hough Company, and is a self contained, four wheel drive, two wheel steer, hydraulically operated, torque converter coupled, power shifted and steered diesel drive unit.
- (2) The Loader is primarily a scoop type tractor shovel with an SAE capacity of 2 cubic yards and an SAE rated capacity of 2 1/2 cubic yards. The H-90CM models bearing serial numbers 27MC-1778 through 27MC-1927 have been equipped with water-proofed transmission and axle housings enabling the units to ford up to three feet of water. These units have been equipped with a fork lift attachment (figs. 3.1, 3.2 and 3.3) and have a lifting capacity of 10,000 pounds. The fork lift can be raised, lowered and tilted forward or backward from the operator's compartment. The forks can be manually adjusted to handle loads of various widths. An overhead guard is provided to prevent injury to the operator. The fork lift attachment is completely interchangeable with the multi-segment bucket.

Page 5. Paragraph 5b, Engine, following line 6, add:

High idle speed ----- 2,350 rpm

Low idle speed ----- 550 rpm

After Paragraph 5e, Bucket, add:

e.1.

*Fork Lift*

Lift capacity ----- 10,000 lbs  
Fork width  
Minimum ----- 16 1/2 inches  
Maximum ----- 75 inches  
Fork length ----- 60 inches  
Weights  
Counterweights ----- 1,000 lbs each  
Lifting height,  
maximum  
Overall ----- 180 inches  
Level fork ----- 132 inches  
Length  
Overall, fork on  
ground ----- 289 inches

*Angle of operation*

3 ft. above ground  
empty back ----- 40°  
forward ----- 30°

*Maximum lift*

height, loaded  
back ----- 65°  
forward ----- 10°

*Weight*

Forks ----- 360 lbs each  
Carrier ----- 1,100 lbs  
Overhead guard ----- 210 lbs

Page 6. Paragraph 5m, is superseded as follows:

m. *Electrical System*

Voltage ----- 24  
Batteries ----- 4  
Voltage ----- 12  
Type ----- Lead acid  
Headlights ----- 1 blackout, 1 regular  
Floodlights -----  
Tail and Stoplight ----- 1 blackout, 2 regular

*(Serial numbers*

27MC-1001  
through 27MC-  
1406)

Tail and Stoplight ----- 1 blackout

*(Serial numbers*

27MC-1501  
through 27MC-  
1927 and 27MC-  
2013 through  
27MC-2702)

Rear turn, Tail, and Stoplight. 2  
 (Serial nos. 27MC-1501  
 through 27MC-1927 and 27-  
 MC 2013 through 27MC-2702)  
 Front turn and Park light. .... 2  
 (Serial nos. 27MC-1501  
 through 27MC-1927 and  
 27MC-2013 through  
 27MC-2702)

Circuit breaker. .... 3  
 (Serial nos. 27MC-1001  
 through 27MC-1406)  
 Circuit breaker ..... 2  
 (Serial nos. 27MC-1501  
 through 27MC-1927 and  
 27MC-2013 through  
 27MC-2702)  
 Circuit breaker rating ..... 15 amp

Paragraph 5p is superseded as follows:

*p. Pressures.*

Main hydraulic system  
 Boom and bucket circuit. .... 2000 psi max  
 Boom clam circuit ..... 2200 psi max  
 Converter and transmission  
 system:  
 Clutch ..... 225 to 240 psi

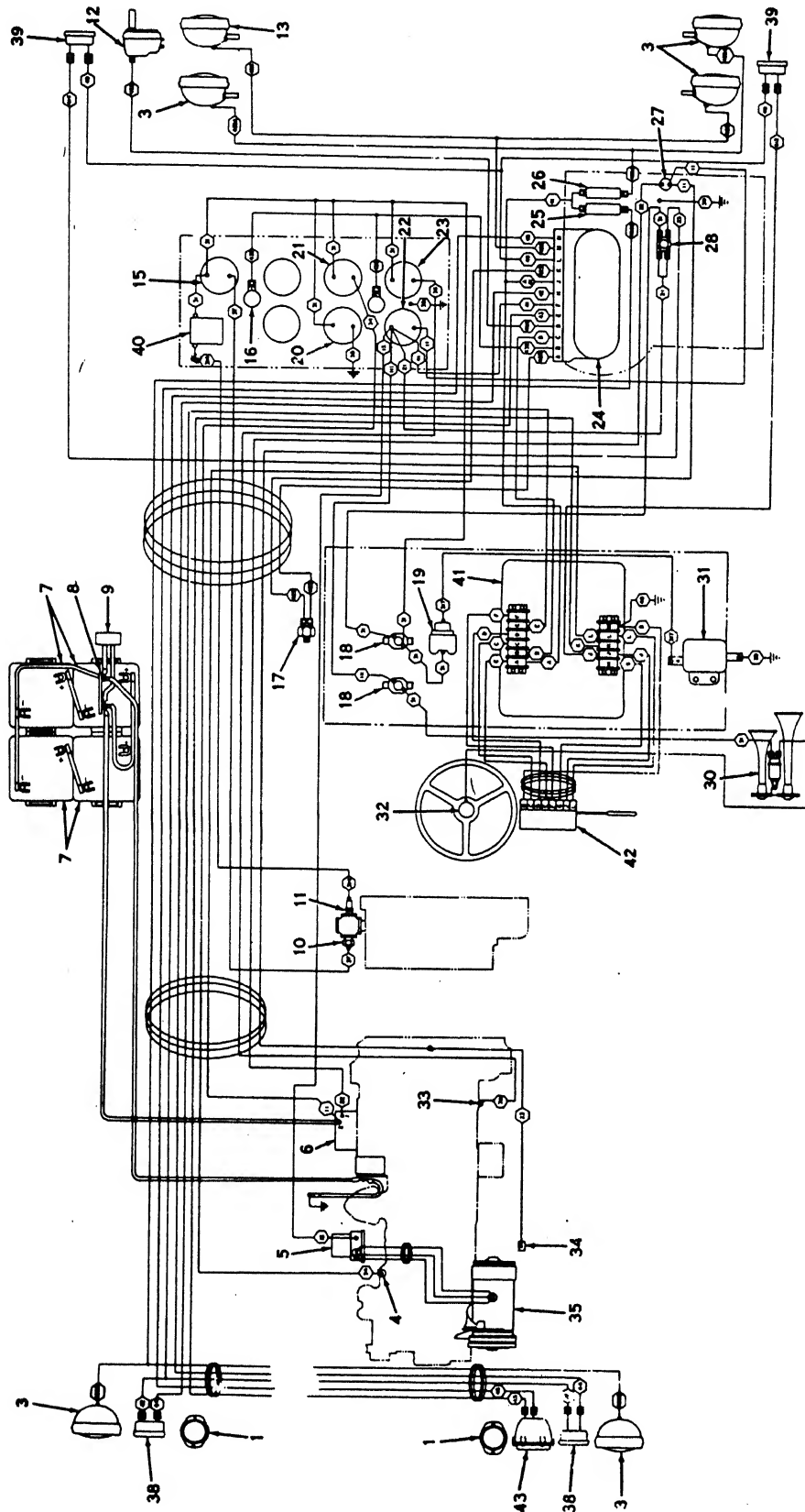
Lube oil ..... 23 to 40 psi  
 Steering hydraulic system ---- 1500 psi max  
 1000 psi min  
 Brake system (air) ..... 85 to 105 lb.  
 Engine lube oil,  
 high idle. .... 30 to 50 psi

Page 8. Figure 4, after caption add:

(Serial nos. 27MC-1001 through 27MC-1406)

Following figure 4 add:





MEC 3805-201-15/4.1 C3

- |                             |                             |   |
|-----------------------------|-----------------------------|---|
| 1 Reflector                 | 22 Ammeter                  | 33 Engine oil pressure sender           |
| 3 Floodlight                | 23 Engine oil pressure gage | 34 Fuel pump shutoff solenoid           |
| 4 Engine temperature sender | 24 Light control switch     | 35 Generator                            |
| 5 Voltage regulator         | 25 Rear floodlight switch   | 37 Wiring harness                       |
| 6 Starting motor            | 26 Front floodlight switch  | 38 Rear turn and taillight              |
| 7 Batteries                 | 27 Starter pushbutton       | 39 Front turn and park light            |
| 8 Terminal block            | 28 Ignition switch          | 40 Torque converter warning buzzer      |
| 9 External connector        | 29 Air horn                 | 41 Directional signal light control box |
| 10 Torque converter sender  | 30 Low air pressure buzzer  | 42 Blackout tail and stop light         |
| 11 Torque converter switch  | 32 Horn button              | 43                                      |
- Figure 4.1. Loader electrical system wiring diagram. (Serial nos. 27MC-1501 through 27MC-1927 and 27MC-2013 through 27MC-2702).

**Page 14.** Paragraph 18c is superseded as follows:

*c. Readings.* At low idle, the transmission clutch pressure of a new transmission should read 150 to 220 psi. While working the loader, pressure should not exceed 240 psi. As the transmission wears, pressures will drop progressively from the new transmission pressures. This is normal. Watch for an abrupt change in low idle pressure that might indicate trouble.

After paragraph 20, add:

**20.1. Torque Converter Temperature Warning Buzzer**

(Serial Nos. 27MC-1001 through 27MC-1406, 27MC-1501 through 27MC-1927, and 27MC-2013 through 27MC-2702)

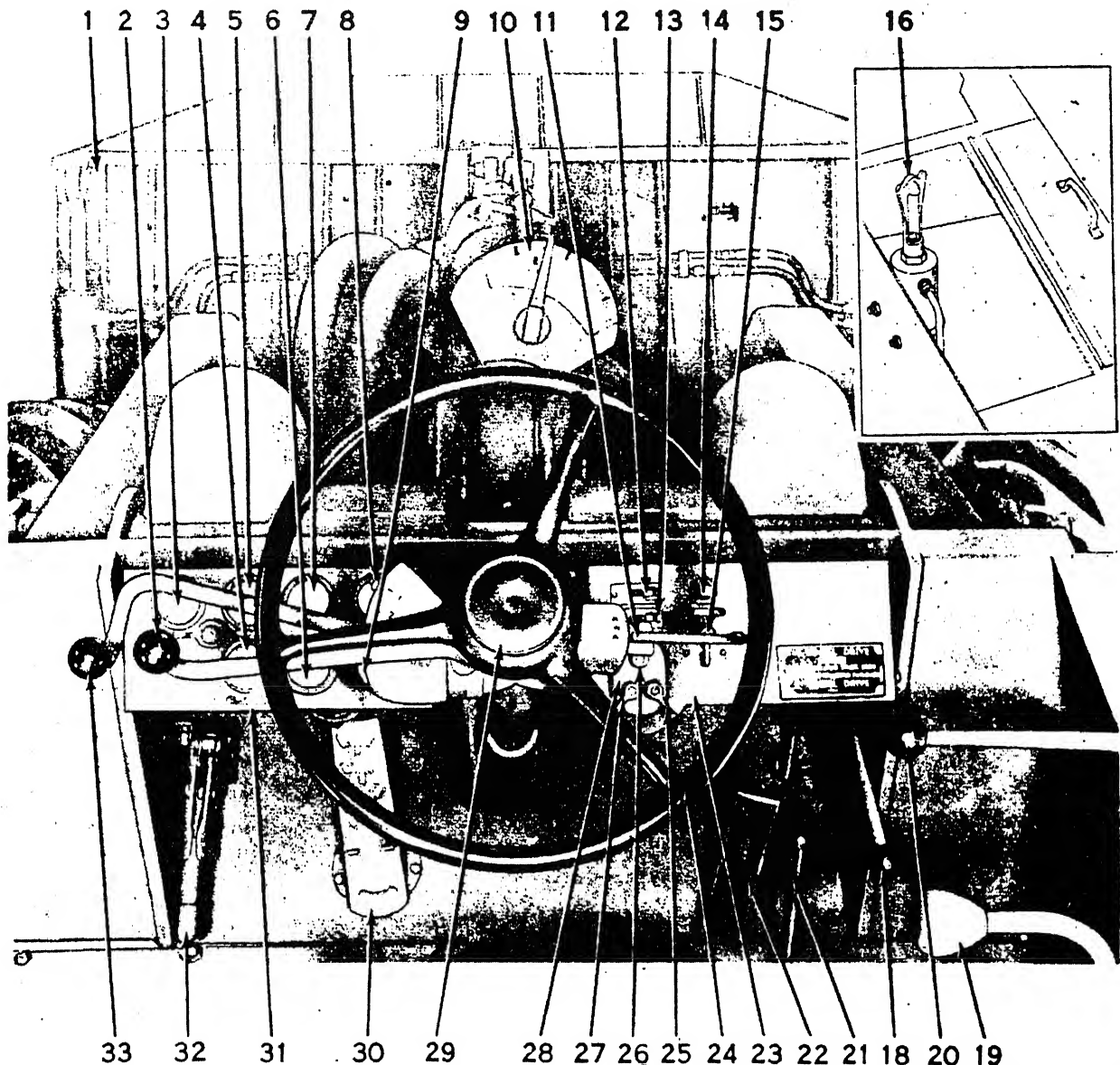
*a. Location.* The torque converter temperature warning buzzer is located under the left side of the instrument panel.

*b. Purpose.* The torque converter temperature warning buzzer sounds to alert the operator of a dangerously high torque converter oil temperature. The buzzer sounds when the temperature reaches 250°F.

**Page 15.** Figure 10, after caption add:

(Serial nos. 27MC-1001 through 27MC-1406)

After figure 10 add:



MEC 3805-201-15/10.1 C3.

- |   |  |
|---|--|
| 1 Bucket opening indicator              | 18 Axle disengage lever                |
| 2 Directional shift lever               | 19 Bucket and accessory control lever  |
| 3 Torque converter oil temperature gage | 20 Boom control lever                  |
| 4 Air pressure gage                     | 21 Hand throttle lever                 |
| 5 Transmission clutch oil pressure gage | 22 Foot throttle                       |
| 6 Hourmeter                             | 23 Light and ignition control panel    |
| 7 Engine temperature gage               | 24 Steering wheel                      |
| 8 Engine oil pressure gage              | 25 Unlock lever                        |
| 9 Ammeter                               | 26 Drive lamp selector switch          |
| 10 Bucket position indicator            | 27 Panel and park lamp selector switch |
| 11 Directional signal light control     | 28 Light control switch                |
| 12 Front floodlight switch              | 29 Horn button                         |
| 13 Rear floodlight switch               | 30 Brake pedal                         |
| 14 Starter pushbutton                   | 31 Instrument panel                    |
| 15 Ignition Switch                      | 32 Parking brake lever                 |
| 16 Primer discharger                    | 33 Range shift lever                   |

Figure 10.1. Controls and instruments (Serial nos. 27MC-1501 through 27MC-1927 and 27MC-2013 through 27MC-2702).

Page 17. Paragraph 31, after title add:

(Serial Nos. 27MC-1001 through 27MC-1406).

After Paragraph 31 add:

**31.1. Directional Signal Light Control (fig. 10.1)**

(Serial Nos. 27MC-1501 through 27MC-1927 and 27MC-2013 through 27MC-2702).

*a. Location.* The directional signal light control (11) is located on the right side of the steering column, under the steering wheel.

*b. Purpose.* The directional signal light control is positioned by the operator to indicate the anticipated direction of turn to personnel in both approaching and following vehicles. When the lever is moved forward, the left front and rear turn lamps blink to indicate that a left turn is anticipated. When the lever is moved to the rear, the right front and rear turn lamps blink to indicate that a right turn is anticipated.

Page 26. After paragraph 45d. add:

**(10) Utilization of fork lift.**

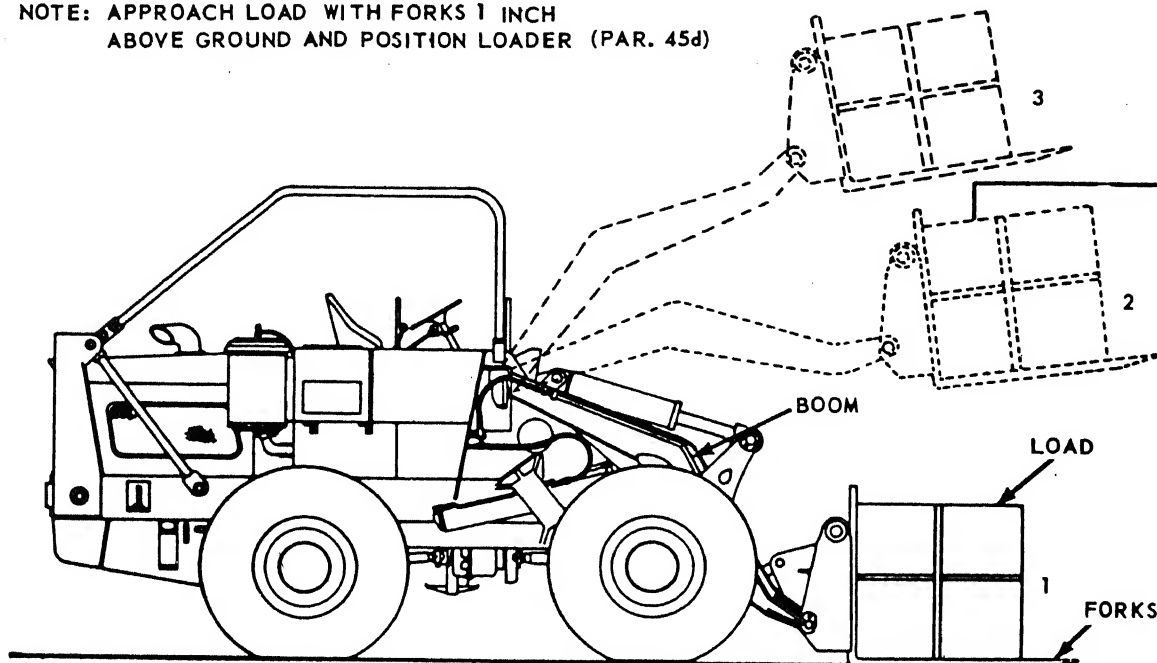
Move loader into position by approaching load at a 90° angle to pick up position. Adjust forks to approaching load at a 90° angle to pick up position. Adjust forks to appropriate width to safely accommodate load. Refer to figure 24.1 for operating details.

*Caution:* Due to the geometry of the loader boom and bucket linkage, the following conditions must be observed:

1. When picking up a load with the fork lift attachment in the raised position, the forks must be tipped slightly to the rear before lowering the load.
2. When picking up a load from the ground, the forks must be tipped slightly to the rear, then as the load is raised, adjust tip-back position with an intermittent "feathering" action of the bucket control lever to avoid too great a tip-back as the boom approaches its maximum height.

After figure 24 add:

NOTE: APPROACH LOAD WITH FORKS 1 INCH ABOVE GROUND AND POSITION LOADER (PAR. 45d)



1. MOVE DIRECTIONAL SHIFT LEVER TO "N".
2. MOVE RANGE SHIFT LEVER TO PROPER POSITION TO RAISE SELECTED LOAD, POSITION 1 FOR A LIGHT LOAD, POSITION 2,3, OR 4 FOR A HEAVIER LOAD.
3. MOVE THE BUCKET AND ACCESSORY SHIFT LEVER TO THE "DUMP" POSITION TO DROP FORWARD END OF FORKS TO THE GROUND.
4. MOVE THE DIRECTIONAL SHIFT LEVER TO "F" AND SLOWLY EASE THE FORKS UNDER THE LOAD. LOAD (1, FIG.24.1).
5. MOVE THE BUCKET AND ACCESSORY LEVER TO THE "ROLL BACK" POSITION SO THAT LOAD IS SLIGHTLY TIPPED BACK. (2, FIG.24.1).
6. MOVE THE BOOM CONTROL LEVER TO THE "RAISE" POSITION AND SLOWLY RAISE THE LOAD FAR ENOUGH TO TRAVEL SAFELY (2, FIG 24.1).
7. POSITION THE LOADER AND RAISE THE BOOM TO CLEAR STORAGE RACK OR TRANSFER BED (3, FIG 24.1).
8. MOVE THE DIRECTIONAL SHIFT LEVER TO "F" AND CAREFULLY MOVE LOADER FORWARD.
9. MOVE THE BOOM CONTROL LEVER TO THE "LOWER" POSITION TO LOWER LOAD TO SELECTED LOCATION.
10. MOVE THE BUCKET AND ACCESSORY LEVER TO THE "DUMP" POSITION AND TIP LOAD SLIGHTLY FORWARD.
11. MOVE THE DIRECTIONAL SHIFT LEVER TO "R" POSITION AND BACKUP, WITHDRAWING FORKS FROM UNDER LOAD.

CAUTION: WHEN MOVING LOADER UNDER OR WITHDRAWING FROM LOAD, OR RAISING OR LOWERING A LOAD ALWAYS USE A FEATHERING OR INTERMITTANT ACTION TO AVOID DROPPING OR OTHERWISE DAMAGING A LOAD.

MEC 3805-201-15/24.1 C3

Figure 24.1. Fork lift operating details (Serial nos. 27MC-1778 through 27MC-1927).

Paragraph 46, after title, add:

(Serial Nos. 27MC-1001 through 27MC-1406).

After paragraph 46, add:

**46.1. Towing a Trailer With Loader**

(Serial Nos. 27MC-1501 through 27MC-1927 and 27MC-2013 through 27MC-2702).

a. The loader is provided with a pintle hook (20, fig. 54.1) to connect towed vehicles. To open the pintle hook remove the cotter pin, lift up the latch, and open the hook. Insert the towing device of the equipment to be towed and close the pintle hook. Insert the cotter pin.

b. When towing another vehicle at night make sure to provide adequate light at the rear of the towed vehicle.

Page 28. Paragraph 47f is superseded as follows:

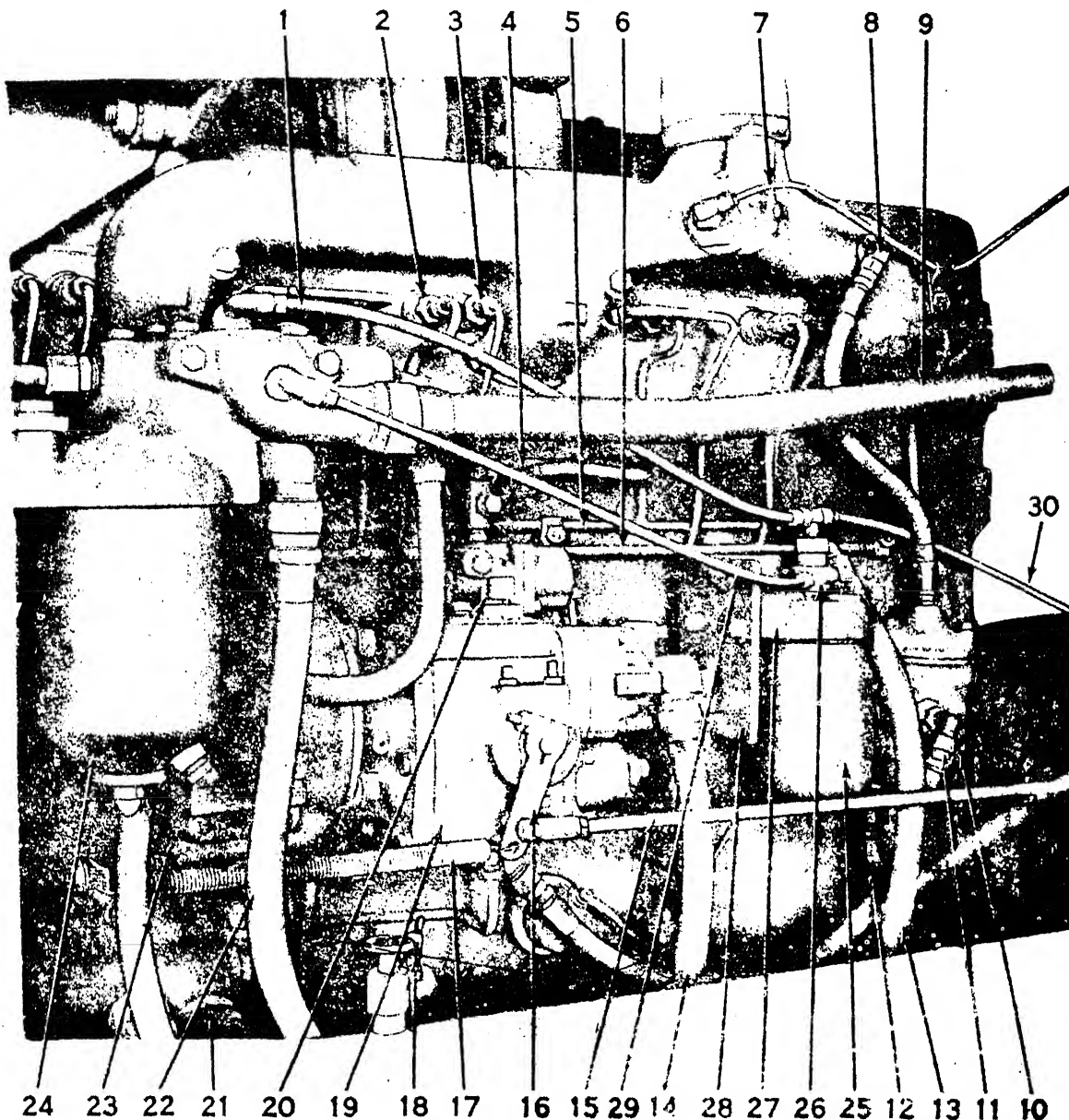
*f. Brake System.*

- (1) On loaders with serial numbers 27MC-1501 through 27MC-1927 and 27MC-2013 through 27MC-2702, maintain a supply of denatured alcohol in the alcohol evaporator during operation in cold weather as directed in paragraph 192. (1)a. The alcohol evaporator will provide a controlled amount of alcohol vapor in the intake air system to prevent the moisture that condenses from the air from freezing in the brake system.
- (2) Immediately after shutting down the loader at any time, drain the moisture that has condensed from the air in the air reservoir. On loaders with serial numbers 27MC-1001 through 27MC-1406, open the air reservoir drain cock on left side of loader, behind the front wheel. On loaders with serial numbers 27MC-1501 through 27MC-1927 and 27MC-2013 through 27MC-2702, open the air reservoir drain cocks on each side of the loader to drain moisture from both sides of the segmented air reservoir. Open the drain cock on the right side first; then open the drain cock on the left side.

Page 62. Figure 35, after caption add:

(Serial numbers 27MC-1001 through 27MC-1406).

After figure 35 add:



MEC 3805-201-15/38.1 C3

- |                                 |                                       |
|---------------------------------|---------------------------------------|
| 1 Compressor-to-evaporator tube | 16 Throttle lever                     |
| 2 Drain connection              | 17 Throttle return spring             |
| 3 Inlet connection              | 18 Oil level gage                     |
| 4 Fuel pump-to-manifold tube    | 19 Fuel pump                          |
| 5 Fuel drain manifold           | 20 Fuel shutoff valve                 |
| 6 Fuel supply manifold          | 21 Lubricating oil pressure regulator |
| 7 Primer discharger line        | 22 Compressor outlet hose             |
| 8 Manifold-to-aneroid hose      | 23 Air compressor                     |
| 9 Air intake tube               | 24 Fuel filter assembly               |
| 10 Aneroid control              | 25 Alcohol evaporator jar             |
| 11 Aneroid pressure hose        | 26 Check valve                        |
| 12 Aneroid suction hose         | 27 Alcohol evaporator body            |
| 13 Manifold drain hose          | 28 Alcohol evaporator bracket         |
| 14 Filter-to-fuel pump hose     | 29 Evaporator-to-compressor tube      |
| 15 Accelerator rod              | 30 Governor-to-evaporator tube        |

Figure 35.1. Fuel pump installation (Serial nos. 27MC-1501 through 27MC-1927 and 27MC-2013 through 27MC-2702).

Page 71. Paragraph 136. Change the paragraph title as follows:

**136. Description**  
(fig. 4 or 4.1).

Paragraph 136e, *Lighting system*. add to title (*Loaders with serial numbers 27MC-1001 through 27MC-1406*).

Paragraph 136e, line 1, after "The lighting system" add "(fig. 4)".

After paragraph 136e, add:

e.1. *Lighting System (Loaders with serial numbers 27MC-1501 through 27MC-1927 and 27MC-2013 through 27MC-2702)*. The lighting system (fig. 4.1) provides lights necessary for normal operation as well as for blackout operation. The main control of the lighting system is provided by the light control switch (24) which incorporates a locking feature to prevent accidental operation of the regular lights during blackout conditions. The rear turn and tail-lights (38) are operated by a stoplight switch (17) which is mounted on the brake system power cluster and which closes when the brake is operated. The lights are also operated selectively as blinkers when the directional signal light control (42) is operated. The front turn and park lights (39) operate together to provide parking lights under control of the light control switch and also operate selectively as blinkers under control of the directional signal light control. The rear floodlight switch (25) and the front floodlight switch (26) are provided for normal lamp operation.

Paragraph 136h, *Circuit Breakers*. Add to title (*Loaders with serial nos. 27MC-1001 through 27MC-1406*).

Paragraph 136h, line 1, after "Three circuit breakers" add "(18, fig. 4)".

After paragraph 136h, add:

h.1. *Circuit breakers (Loaders with serial nos. 27MC-1501 through 27MC-1927 and 27MC-2013 through 27MC-2702)*. Two circuit breakers (18, fig. 4.1) are used to protect the electrical circuits from overload. One circuit breaker protects all circuits that are connected through the main ignition switch (28). The second protects the circuit to the horn.

Page 76. Figure 52. Legend, add to callout 11: (Serial Nos. 27MC-1001 through 27MC-1404 and 27MC-1501 through 27MC-1927).

Figure 52. Legend, after callout 11 add:

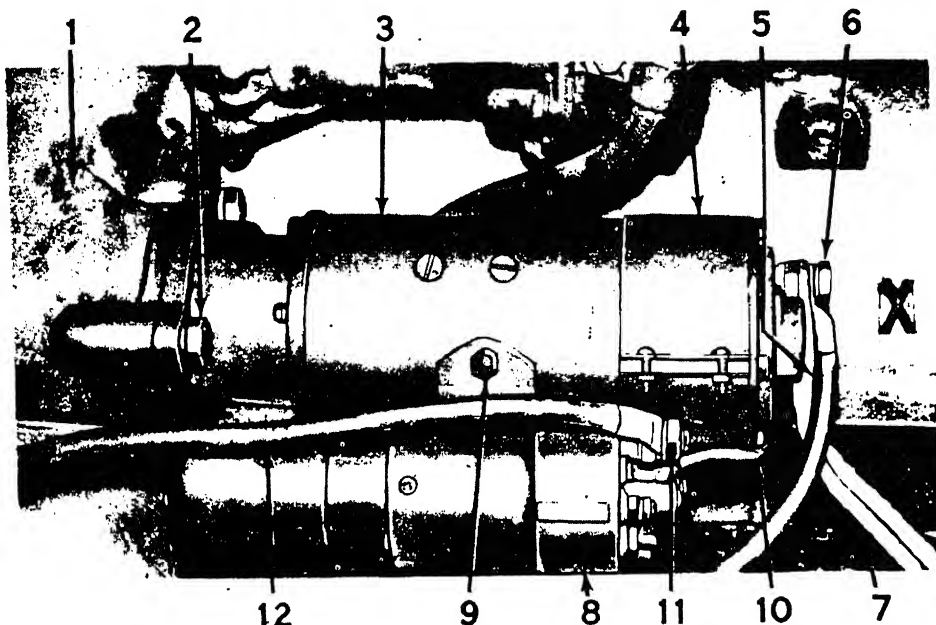
11.1 Nut (Serial nos. 27MC-2013 through 27MC-2702).

Figure 52, after caption add:

(Serial nos. 27MC-1001 through 27MC-1406 and 27MC-1501 through 27MC-1927).

After figure 52, add:





MEC 3805-201-15/52.1 C3.

- |                            |                                  |
|----------------------------|----------------------------------|
| 1 Flywheel housing         | 7 Ground strap                   |
| 2 Capscrew                 | 8 Starter switch assembly        |
| 3 Starting motor           | 9 Capscrew                       |
| 4 Cover band               | 10 Starter button-to-switch lead |
| 5 Battery-to-starter cable | 11 Nut                           |
| 6 Nut                      | 12 Battery-to-switch cable       |

Figure 52.1. Starting motor installation (Serial nos. 27MC-2013 through 27MC-2702).

Page 77. Paragraph 141, change the paragraph title as follows:

**141. Starting Motor (fig. 52 or 52.1).**

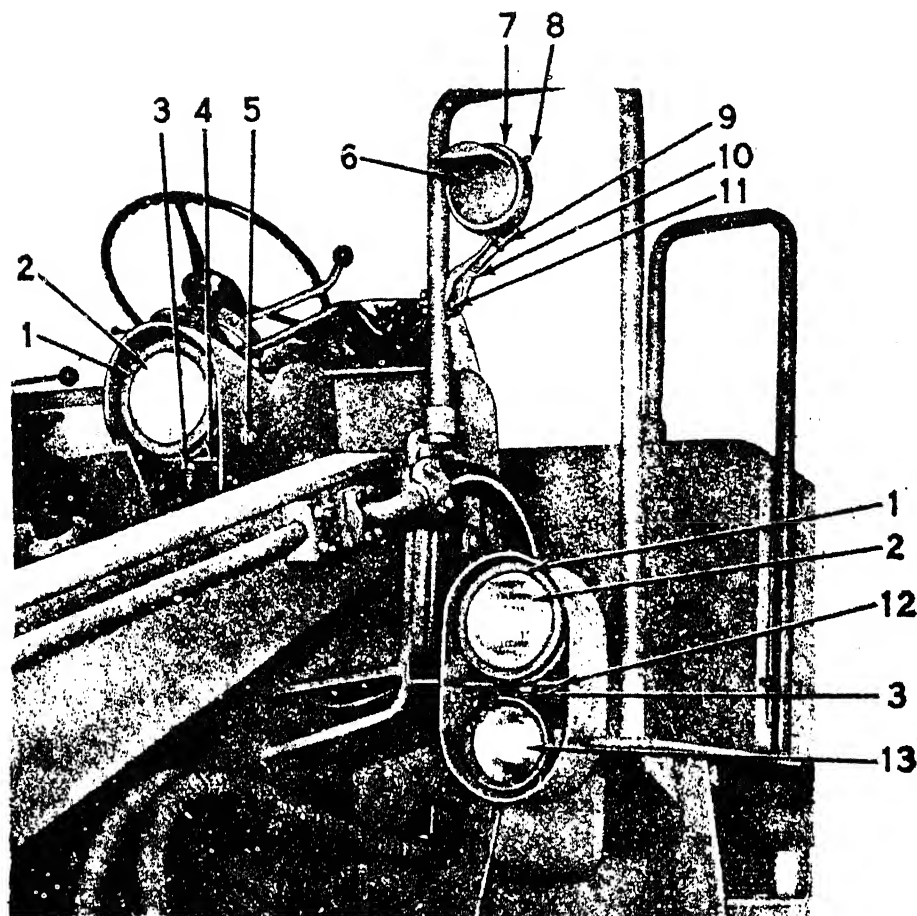
Paragraph 141b. Change the first line of subparagraph (4) to read:

"(4) Remove the capscrew (11, fig. 52) of machines with serial numbers 27MC-1001 through 27MC-1406 and 27MC-1501 through 27MC-1927, or the nut (11, fig. 52.1) that secures the"

Page 78. Figure 53, after caption, add:

(Serial nos. 27MC-1001 through 27MC-1406).

After figure 53 add:



MEC 3805-201-15/53.1 C3

- 1 Molded ring
- 2 Sealed unit
- 3 Nut
- 4 Bracket
- 5 Capscrew
- 6 Sealed unit
- 7 Door assembly

- 8 Captive screw
- 9 Nut
- 10 Bracket
- 11 Nut
- 12 Bracket
- 13 Turn and park lamp

*Figure 53.1. Front light installation (Serial nos. 27MC-1501 through 27MC-1927 and 27MC-2013 through 27MC-2702).*

Page 79. Paragraph 144, after the title, add:

**(Serial Nos. 27MC-1001 through 27MC-1406) (fig. 54).**

Paragraph 145, after the title, add:

**(Serial Nos. 27MC-1001 through 27MC-1406) (fig. 54).**

After paragraph 145 add:

#### **145.1. Blackout Tail and Spotlight**

(Serial Nos. 27MC-1501 through 27MC-1927 and 27MC-2013 through 27MC-2702) (fig. 54.1).

##### *a. Bulb Replacement.*

- (1) Loosen the six captive screws (21) that secure the door (18) to the light body; remove the door assembly and gasket.
- (2) To remove the defective bulb, press inward, give the bulb a quarter turn, and pull out.
- (3) Insert a new bulb in the socket of the housing, press inward, and give the bulb a quarter turn to secure it to the socket.
- (4) Position the gasket and door assembly (18) on the housing; secure by tightening the six captive screws (21).

##### *b. Removal.*

- (1) Disconnect the electrical leads of the tail and stoplights.
- (2) Remove the two capscrews and lockwashers that secure each of the two tail and stoplights to the frame; remove the tail and stoplights.

##### *c. Cleaning and Inspection.*

- (1) Clean the lamp bulbs and lenses with a cloth dampened with water.
- (2) Clean all metallic parts with a cloth dampened with an approved cleaning solvent; dry thoroughly.
- (3) Inspect the bulbs for discoloration of the glass and for damaged pins on the bayonet base; replace damaged bulbs.
- (4) Inspect leads and sockets for cracks, damaged insulation, and deterioration. Inspect metallic parts for cracks or distortion. Replace damaged parts.

*d. Installation* Install the tail and stoplights by reversing the removal procedure given in subparagraph *b* above.

After paragraph 145.1 add:

#### **145.2 Turn Signal Lights (Serial Nos. 27MC-1501 through 27MC-1927 and 27MC-2013 through 27MC-2702).**

*Note.* The front turn and park lights (13, fig 53.1) and the rear turn and taillights (17, fig. 54.1) serve double purposes by use of dual element lamps. Construction of lamps is identical except for color of lenses.

##### *a. Bulb Replacement.*

- (1) Spread the molded rubber lens retainer and remove the lens.
- (2) Press inward and give the bulb a quarter turn to release it from the socket in the body.
- (3) Insert a new bulb in the socket, depress the socket, insert it, and give it a quarter turn to secure it to the socket.
- (4) Insert the lens in the molded rubber retainer.

##### *b. Removal.*

- (1) Disconnect the electrical leads from the light.
- (2) Remove the nut and washer that secure the light to the loader; remove the light.
- (3) Remove the lens and lamp from the light as directed in subparagraph *a* above.

##### *c. Cleaning and Inspection.*

- (1) Clean the bulb and lens with warm soapy water.

- (2) Clean the interior and exterior of the body with an approved cleaning solvent; dry thoroughly.
- (3) Inspect the bulb for broken filaments, discoloration, and for damaged pins on the bayonet base; replace if necessary.
- (4) Inspect the body for cracks, distortion, frayed or damaged lead insulation, deteriorated rubber parts, and other damage; replace if damaged.

*d. Installation.* Install the turn signal lights by reversing the removal procedure described in subparagraph *b* above.

Paragraph 146 *a* (2) after "(2)" add:  
loaders with serial numbers 27MC-1001 through 27MC-1406"

Page 80. Paragraph 146*a* (4), after paragraph add:

*Note.* Steps (5) through (7) are applicable only to loaders with Serial numbers 27MC-1501 through 27MC-1927 and 27MC-2013 through 27MC-2702.

Paragraph 146*a* (4), after "Note" add:

- (5) Disconnect all electrical leads from the directional signal light control (11, fig. 10.1) to the directional signal distribution box (41, fig. 4.1). Loosen the screw that clamps the directional signal light control to the steering column of the tractor; remove the light control.
- (6) Remove the two screws that secure the directional signal distribution box to the truck frame under the left side of the instrument panel; remove the distribution box.
- (7) Disconnect the electrical leads to the torque converter warning buzzer (40) under the left side of the instrument panel. Remove the two screws and nuts that secure the buzzer and insulator block to the instrument panel; remove the buzzer and insulator block.

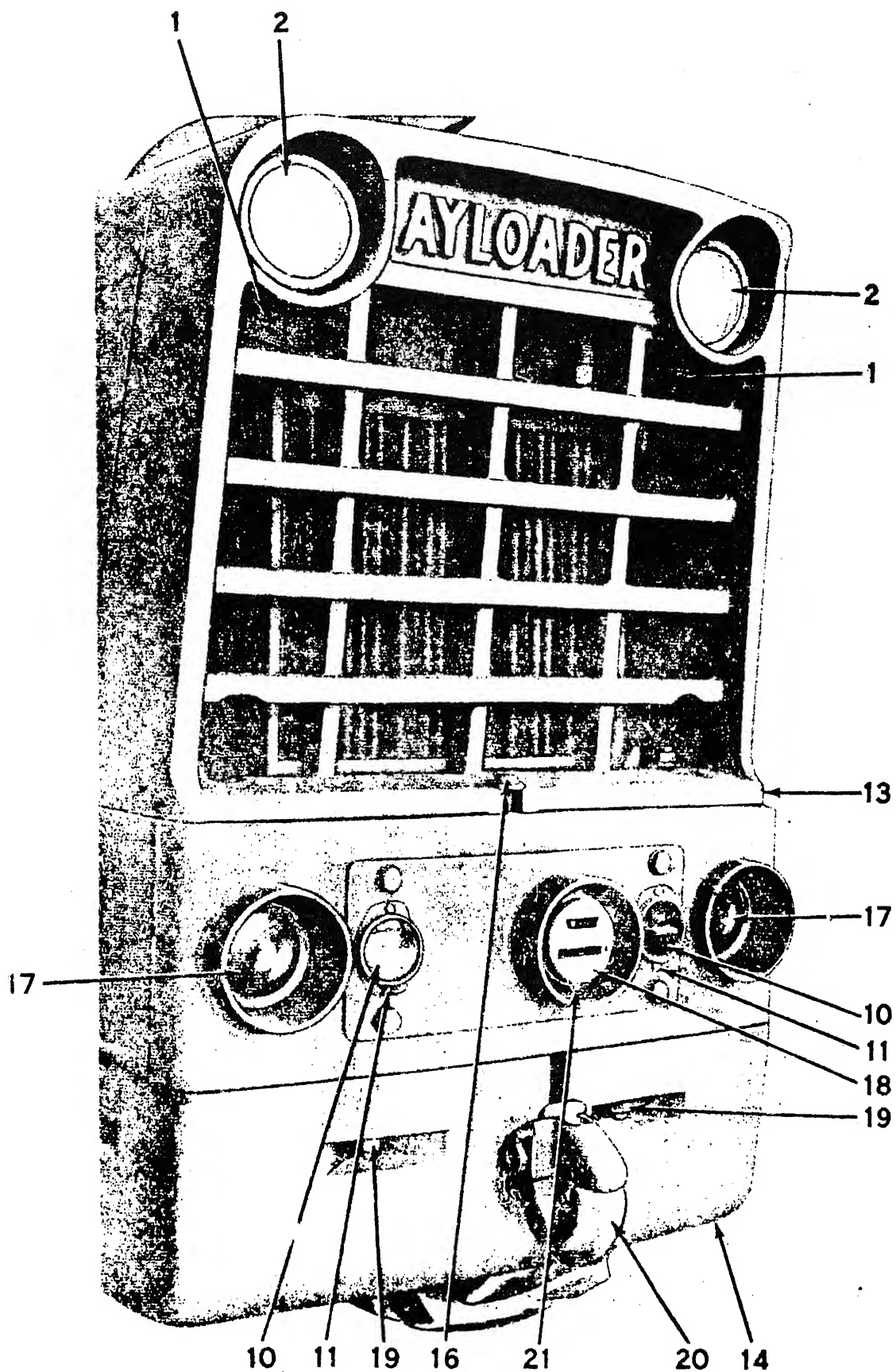
Figure 54, after caption add:

(Serial nos. 27MC-1001 through 27MC-1406).

Following figure 54 add:

1 Nut  
2 Floodlight  
10 Reflector  
11 Capscrew  
13 Grille  
14 Counterweight

16 Capscrew  
17 Turn, tail, and stoplight  
18 Blackout tail and stoplight door  
19 Nut  
20 Pintle hook  
21 Captive screw



MEC 3805-201-15/54.1 C3

Figure 54.1. Rear light installation (Serial nos. 27MC-1501 through 27MC-1927 and 27MC-2013 through 27MC-2702).

**Page 95.** Paragraphs 163c(5) and (5) are superseded as follows:

- (5) Remove the screw and lockwasher that secure the clip (1) to the turbocharger (27): remove the clip.
- (6) Disconnect the oil drain hose (21) from the adapter (23) and from the connection on the engine block; remove the oil drain hose; adapter, coupling (24) and nipple (25) from the turbocharger.

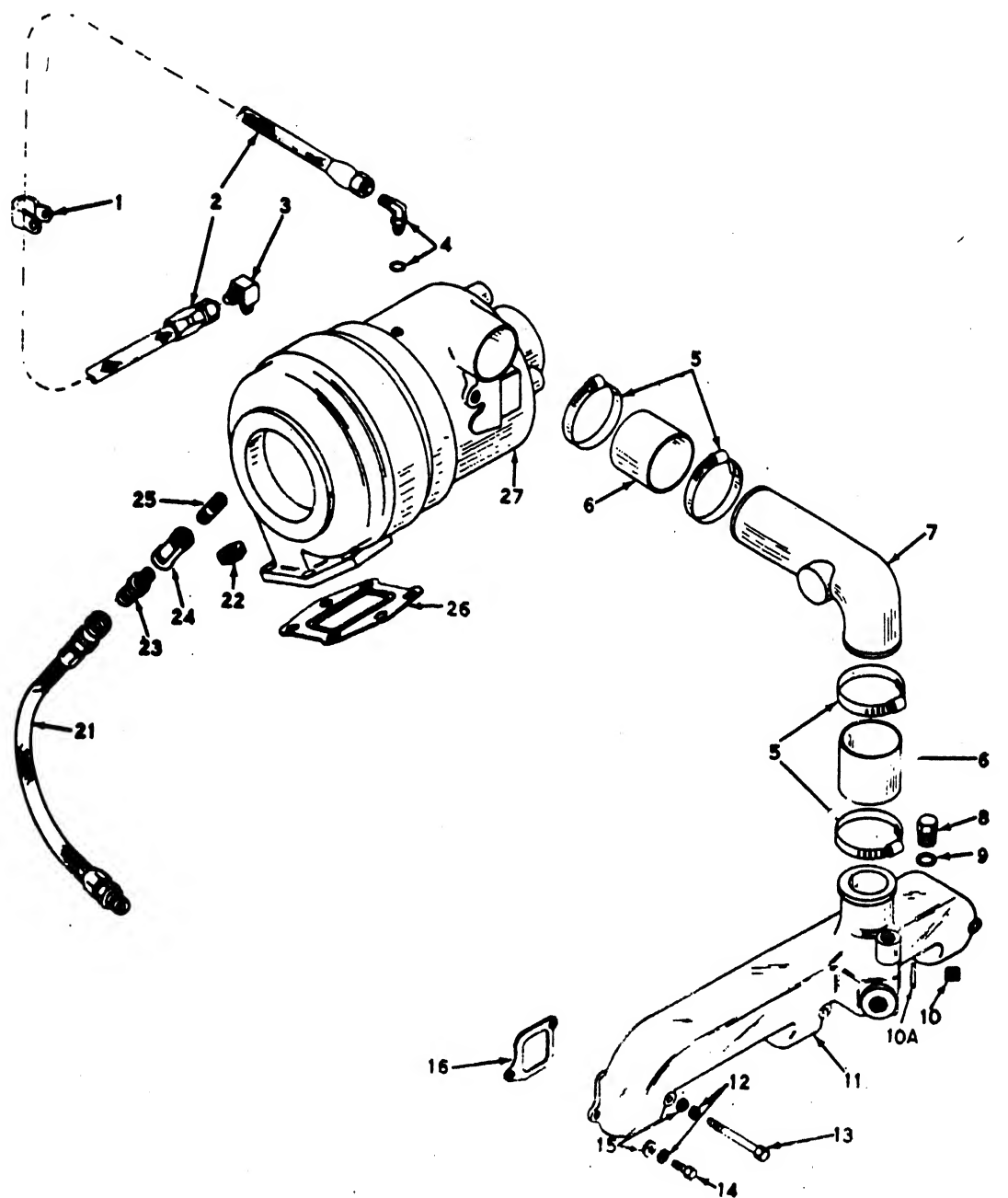
Paragraph 163e(2) is superseded as follows:

- (2) Install the nipple (25), coupling (24), and adapter (23) on the turbocharger; connect the oil drain hose (21) to the adapter and to the connection on the engine block.

Paragraph 163e(4) is superseded as follows:

- (4) Position the clip (1) on the oil supply hose; secure to the turbocharger with a screw and lockwasher.

Page 96. Figure 70 is superseded as follows:



MEC 3805-201-15/70 C3

- |                         |                    |                           |
|-------------------------|--------------------|---------------------------|
| 1 Clip                  | 9 Gasket           | 16 Intake manifold gasket |
| 2 Oil supply hose       | 10 Plug            | 21 Oil drain hose         |
| 3 Elbow                 | 10A Gasket         | 22 Locknut                |
| 4 Connection            | 11 Intake manifold | 23 Adapter                |
| 5 Hose clamp            | 12 Lockwasher      | 24 Coupling               |
| 6 Hose                  | 13 Screw           | 25 Nipple                 |
| 7 Air intake connection | 14 Screw           | 26 Gasket                 |
| 8 Plug                  | 15 Flat washer     | 27 Turbocharger           |

Figure 70. Intake manifold and turbocharger connections, exploded view.

Page 117. Paragraph 185a, delete lines 23 through 16 and replace with:

"axles. On loaders with serial numbers 27MC-1001 through 27MC-1406, a service coupling provides air for the brake system of a towed vehicle, while an emergency coupling (39) supplies air for the emergency brake system of a towed vehicle. The"

Following paragraph 185b, add subparagraph b.1.

b.1. On loaders with serial numbers 27MC-1501 through 27MC-1927 and 27MC-2013 through 27MC-2702, an alcohol evaporator is connected into the air system between the governor and compressor. The alcohol evaporator is used in cold weather to prevent freezing of the water that is taken into the system with the air and which condenses when subjected to the pressure of the air system. The freezing of air components can prevent free movement of the brake parts and result in brake failure. Part of the air taken in by the compressor is bubbled through the alcohol in the evaporator jar and entrains alcohol. This air is then taken into the air system and is mixed with the other intake air to provide an air-alcohol mixture. The intake air also contains moisture since the air normally contains some humidity. As the air-water-alcohol mixture is subjected to pressure in the air system, the alcohol and water condense, resulting in a solution that will not freeze at temperatures normally encountered.

Paragraph 185c, delete the first line and replace with:

c. On loaders with serial numbers 27MC-1001 through 27MC-1406, a handbrake valve (1), mounted on the,

Paragraph 185g, delete the first line and replace with the following:

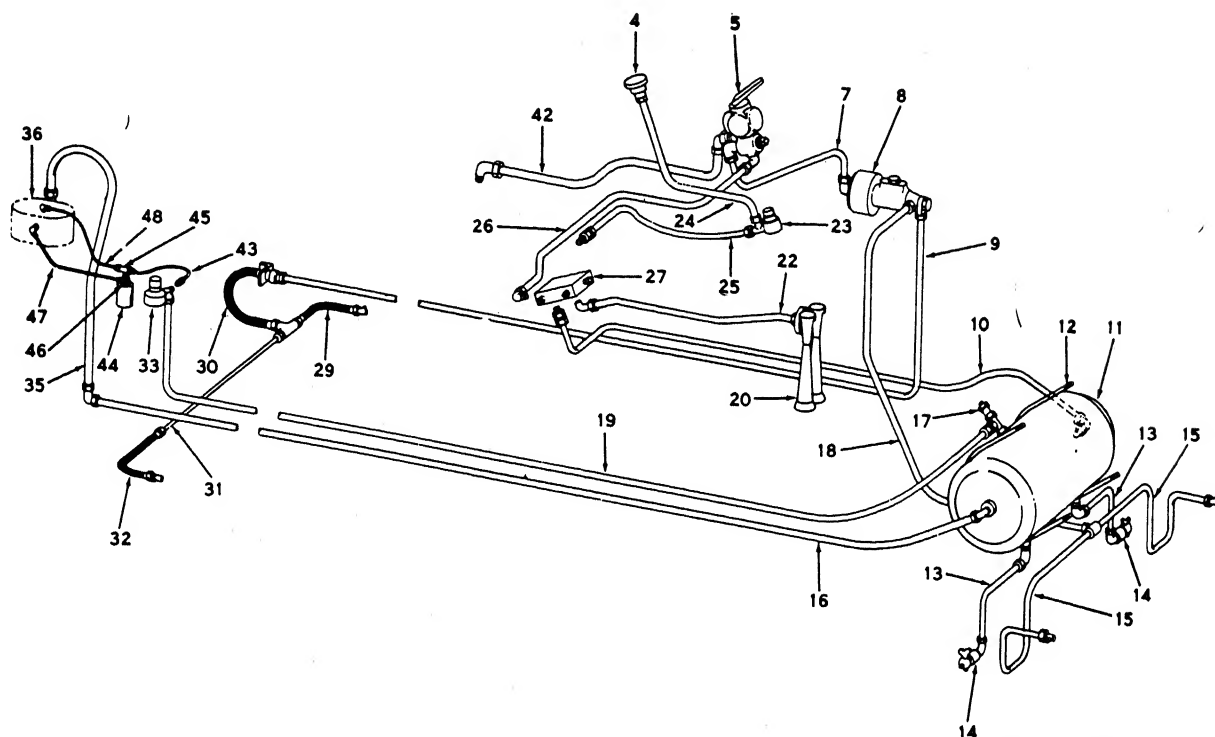
g. On loaders with serial numbers 27MC-1001 through 27MC-1406, a double check valve (6) prevents loss.

Page 118. Figure 83, after caption add:

(Serial nos. 27MC-1001 through 27MC-1406),

Following figure 83 add:





MEC 3805-201-15/83.1 C3

- |                                       |   |
|---------------------------------------|---|
| 4 Air pressure gage                   | 24 Low pressure indicator-to-air pressure gage tube |
| 5 Treadle valve                       | 25 Manifold-to-low pressure indicator tube          |
| 7 Treadle valve-to-power cluster tube | 26 Manifold-to-treadle valve tube                   |
| 8 Power cluster                       | 27 Manifold   |
| 9 Power cluster-to-rear brake tube    | 29 Power cluster tube-to-left rear brake hose       |
| 10 Reservoir-to-manifold tube         | 30 Power cluster tube-to-rear brake hose            |
| 11 Air reservoir                      | 31 Rear brake hose-to-right rear brake tube         |
| 12 U-bolt                             | 32 Rear brake hose-to-right rear brake hose         |
| 13 Reservoir drain tube               | 33 Governor   |
| 14 Drain cock                         | 35 Compressor outlet tube                           |
| 15 Front brake tube                   | 36 Air compressor                                   |
| 16 Compressor-to-reservoir tube       | 42 Treadle valve-to-transmission tube               |
| 17 Safety valve                       | 43 Governor-to-evaporator tee tube                  |
| 18 Power cluster-to-front brakes tube | 44 Alcohol evaporator                               |
| 19 Reservoir-to-governor tube         | 45 Tee  |
| 20 Horn                               | 46 Check valve                                      |
| 22 Manifold-to-horn tube              | 47 Evaporator-to-compressor tube                    |
| 23 Low pressure indicator             | 48 Compressor-to-evaporator tube                    |

Figure 83.1. Air brake system, schematic view (Serial nos. 27MC-1501 through 27MC-1927 and 27MC-2013 through 27MC-2702).

Page 120. Paragraph 187c (1), delete first line and replace with:

- (1) Open the drain cock (14, fig. 83) or drain cocks (14, fig. 83.1) and allow.

Paragraph 188, title, change to read;

#### "Air Reservoir"

Paragraph 188a (1), delete and replace with:

- (1) Open the drain cock (14, fig. 83 or 83.1), and allow the air system to drain. On loaders with serial numbers 27MC-1501 through 27MC-1927 and 27MC-2013 through 27MC-2702, open both drain cocks to drain both sections of the reservoir.

Paragraph 188a (6), is added as follows:

- (6) On loaders with serial numbers 27MC-1501 through 27MC-1927 and 27MC-2013 through 27MC-2702, carefully remove the cap nut (1, fig. 85.1) and assembled preformed packing (2) springs (3 and 4), check valve (5), and the assembled valve seat (6) and preformed packing (7) from the air reservoir (8). Remove the preformed packings from the associated parts.

Paragraph 188b (5), is added as follows:

- (5) Inspect the check valve parts used on loaders with serial numbers 27MC-1501 through 27MC-1927 and 27MC-2013 through 27MC-2702 for cracks, distorted springs, scoring distortion, and other damage. Discard preformed packings and replace with new packings.

Following figure 85 add:

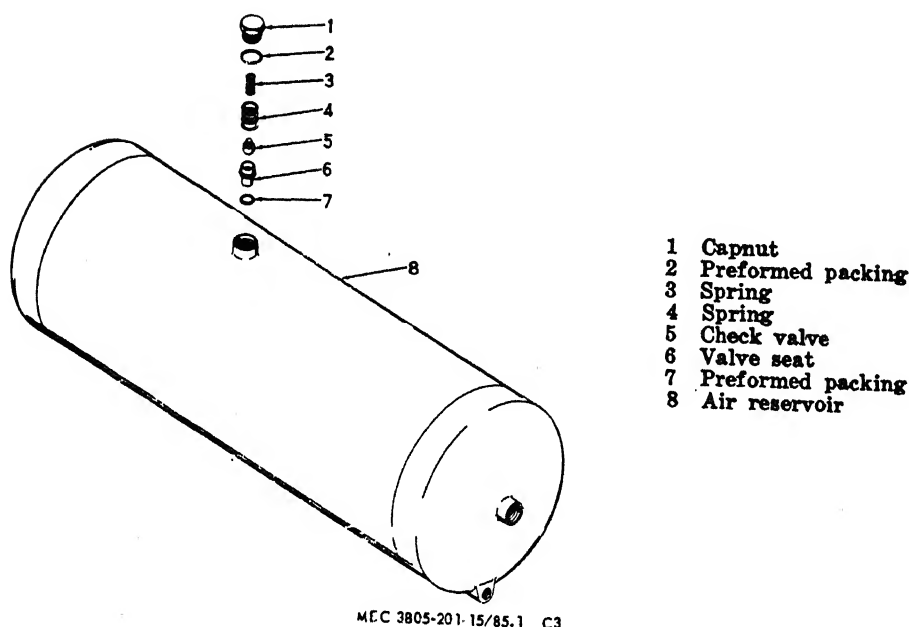


Figure 85.1. Air reservoir, showing check valve parts.  
(Serial nos. 27MC-1501 through 27MC-1927 and  
27MC-2013 through 27MC-2702).

Paragraph 189, after title, add:

(Serial Nos. 27MC-1001 through 27MC-1406).

Paragraph 190, after title add:

(Serial Nos. 27MC-1001 through 27MC-1406).

Page 121. Paragraph 191a (1), delete the first line and replace with:

- (1) Open the drain cock (14, fig. 83) or drain cocks (14, fig. 83.1) and allow.

After paragraph 192, add:

#### 192.1 Alcohol Evaporator and Check Valve

(Serial Nos. 27MC-1501 through 27MC-1927 and 27MC-2013 through 27MC-2702).

##### a. Service.

- (1) Use the alcohol evaporator to prevent freezing of moisture that condenses in the air system whenever ambient temperature reaches 40°F or lower.

- (2) To service the alcohol evaporator, unscrew the plastic jar from the evaporator and rinse any residue from it using denatured alcohol. Fill the jar with denatured alcohol and install it on the evaporator.

**Warning:** Denatured alcohol, if taken internally, can cause severe illness, blindness, and even death. Do not drink denatured alcohol.

*b. Removal and Disassembly.*

- (1) Disconnect the tubes (43, 47, and 48, fig. 83.1) from the check valve (46) and from the tee (45) on the evaporator.
- (2) Remove the three capscrews, lockwashers, and nuts that secure the evaporator to the loader; remove the assembled check valve, evaporator and tee.
- (3) Remove the tee and check valve from the evaporator.

*c. Cleaning and Inspection.*

- (1) Remove the retaining ring that holds the filter parts in the evaporator body. Remove the filter and flush it through with denatured alcohol. Shake dry and replace the filter. Clean all other parts with denatured alcohol and dry.
- (2) Inspect the check valve for cracks, worn or damaged threads, or other damage; replace a damaged check valve.
- (3) Inspect the evaporator for cracks, distortion, or damage; replace if damaged.

*d. Installation.* Install the alcohol evaporator, check valve, and tee by reversing the removal procedure given in subparagraph *b*, above. Connect tubes as shown in figure 83.1.

**Page 122.** Paragraph 193*a* (1), delete the first line and replace with the following:

- (1) Open the drain cock (14, fig. 83) or drain cocks (14, fig. 83.1) and allow.

Paragraph 194, after title, add:

**(Serial Nos. 27MC-1001 through 27MC-1406).**

**Page 123.** Paragraph 195*a* (1) is superseded as follows:

- (1) Open the drain cock (14, fig. 83) or drain cocks (14, fig. 83.1) and allow the air system to drain.

Paragraph 195*a* (4) is superseded as follows:

- (4) Disconnect the air inlet tube and the compressor outlet tube (35) from the air compressor. On loaders with serial numbers 27MC-1001 through 27MC-1406, remove the governor-to-compressor tube (34, fig. 83) from the elbow on the air compressor. On loaders with serial numbers 27MC-1501 through 27MC-1927 and 27MC-2013 through 27MC-2702, remove the evaporator-to-compressor tube (47, fig. 83.1) and compressor-to-evaporator tube (48) from the elbows on the compressor.

**Page 124.** Paragraph 195*c* (7) is superseded as follows:

- (7) Install the elbows on the tops and sides of the air compressor cylinder head. On loaders with serial numbers 27MC-1001 through 27MC-1406, connect the governor-to-compressor tube (34, fig. 83) to the elbow at the top of the cylinder head. On loaders with serial numbers 27MC-1501 through 27MC-1927 and 27MC-2013 through 27MC-2702, connect the evaporator-to-compressor tube (47, fig. 83.1) to the elbow on the compressor air intake and connect the compressor-to-air evaporator tube (48) to the elbow at the top of the compressor. On all units, connect the compressor-to-reservoir tube to the fitting at the rear of the compressor cylinder head.

Page 135. Figure 99 is superseded as follows:

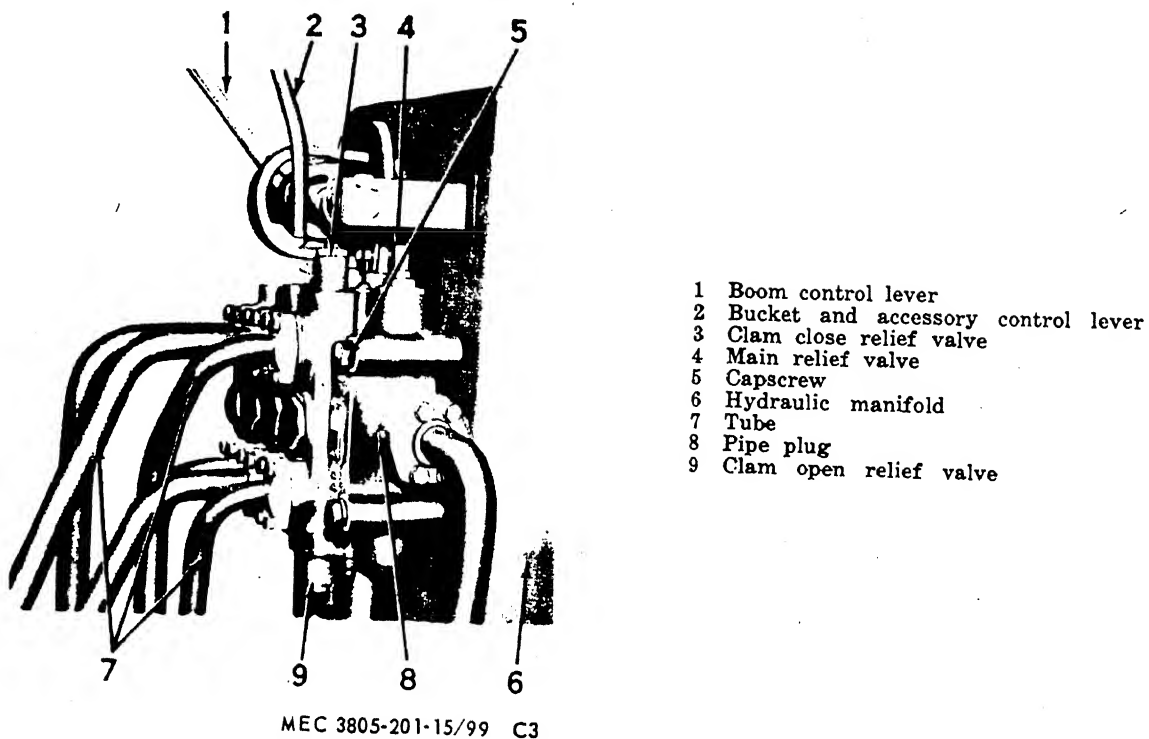


Figure 99. Hydraulic control valve installation.

Paragraph 207a is superseded as follows:

*a. Main Relief Valve Minor Adjustment.*

- (1) With engine shut off, remove the pipe plug (8, fig. 99) from the hydraulic control valve housing and install an accurate hydraulic pressure gage with a rating of 3,000 psi.
- (2) Apply the parking brake and position all controls in neutral position; start the engine.
- (3) After the engine and hydraulic system have been warmed up, move the bucket control lever to the ROLL BACK position. Gradually advance the engine speed to full throttle, while observing the pressure indicated on the gage. It should read 2,000 psi maximum.
- (4) If the pressure is not 2,000 psi, remove the adjusting screw cover (1, fig. 100), loosen the jam nut (2), and use a screwdriver to turn the adjusting screw (3) clockwise to increase pressure, and counterclockwise to decrease pressure to obtain the required 2,000 psi.

**Caution:** Do not bottom the adjusting screw (3) in the valve assembly during this adjustment.

- (5) Decrease the engine speed and release the bucket control lever. Hold the adjusting screw (3) with a screwdriver and lock the valve adjustment with the jam nut (2).
- (6) Stop the engine after the adjustment is completed and remove the hydraulic pressure gage from the port in the control valve housing. Replace the pipe plug (8, fig. 99)

*a.1. Main Relief Valve Major Adjustment.* Major adjustment is usually required only after reassembling the relief valve after overhaul, or after installing a new hydraulic pump.

- (1) Follow the procedure outlined in paragraph 207a, (1 thru 3).

- (2) Shut off the engine. With the relief valve assembly in place, remove the adjusting screw cover (1, fig. 100) and loosen the jam nut (2). Very gently turn the adjusting screw (3) clockwise until it bottoms against the pilot poppet (5).
  - (3) Using the adjusting tool (11), back out the inner adjusting nut (4) until it is flush with the face of the adjusting screw plug (12).
  - (4) Accelerate the engine to about 1,000 rpm and hold the bucket control lever in the bucket ROLL BACK position.
  - (5) Slowly adjust the inner adjusting nut (4) to obtain a gage reading of 2,200 psi with the engine running at about 1000 rpm.
  - (6) Decrease the engine speed to idle. Turn the adjusting screw (3) six full turns counterclockwise while holding the inner adjusting nut (4) with the adjusting tool (11).
  - (7) Operate the bucket control lever to the bucket ROLL BACK position and accelerate the engine to full throttle speed. Turn the adjusting screw (3) clockwise to obtain 2,000 psi. Keep the inner adjusting nut (4) from turning while the adjustment is made.
  - (8) Decrease the engine speed to idle and release the bucket control lever. Lock the adjustment with the jam nut (2) and install the adjusting screw cover (1).
- a. 2. *Adjustment of Clam Relief Valves.* To adjust the clam relief valves to the required 2,200 psi, it is necessary to temporarily increase the main relief valve pressure adjustment from 2,000 psi to 2,300 psi.

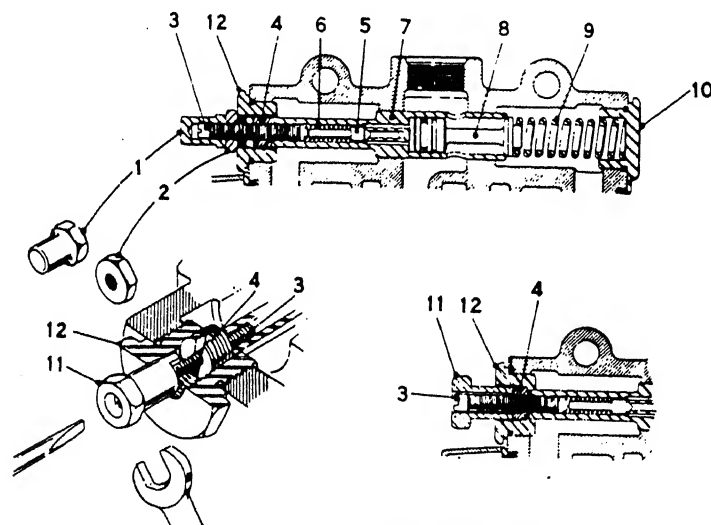
**Caution:** Before working the machine after adjusting the clam relief valves, make sure the main relief valve (4, fig. 99) is reset to the correct operating pressure of 2,000 psi.

- (1) With engine shut off, remove pipe plug (8) from the hydraulic control valve housing and install an accurate hydraulic pressure gage with a rating of 3,000 psi.
- (2) Apply the parking brake and position all controls in neutral position; start the engine.
- (3) Bring the engine and hydraulic system up to normal operating temperatures. Operate the bucket control lever to the bucket ROLL BACK position and gradually increase engine speed to full throttle while observing the pressure indicated on the gage. Pressure will read 2,000 psi if the relief valve is properly adjusted. To adjust the main relief valve (4) temporarily, to the 2,300 psi so as to adjust the clam relief valves (3 and 9), proceed as follows:
  - (a) With the engine at low idle, remove the adjusting screw cover (1, fig. 100), loosen the jam nut (2) and, using a screwdriver, turn the adjusting screw (3) clockwise until it bottoms lightly against its seat.
  - (b) Run the engine at 1000 rpm and move the bucket control lever to the ROLL BACK position. Slowly adjust inner adjusting nut (4), using the adjusting tool (11) to obtain a gage reading of 2,400 psi with engine at 1,000 rpm.
  - (c) Decrease engine speed to low idle. While holding inner adjusting nut (4) with the adjusting tool, loosen the adjusting screw (3) six full turns by turning counterclockwise.
  - (d) Move the bucket control lever to ROLL BACK position and slowly accelerate the engine to full throttle speed. Continue to hold the inner adjusting nut (4) in place with the adjusting tool while turning the adjusting screw (3) clockwise to obtain 2,300 psi with engine at full throttle speed. Tighten the jam nut (2) and replace the adjusting screw cover (1). Shut off the engine.
- (4) The clam circuit has two relief valves. The clam open valve (9, fig. 99) protects the clam circuit from excessive pressures in the clam open circuit. The clam close valve (3) protects the clam circuit from excessive pressures in the clam close circuit.
  - (a) To check the clam open relief valve (9), start the engine and place the bucket control lever in the clam OPEN position. Accelerate engine to 1,000 rpm and ob-

- serve the indication on the hydraulic pressure gage. It should read 2,200 psi. If the gage does not read 2,200 psi, stop the engine and remove the plug (fig. 100.1) from the clam open relief valve (9, fig. 99). Add or remove shims (see shim table on fig. 100.1) as required to obtain 2,200 psi. Replace the plug.
- (b) To check the clam close relief valve (3, fig. 99), place the bucket control lever in the clam CLOSE position and increase engine speed to 1,000 rpm. The pressure gage should read 2,200 psi. If necessary to adjust the relief valve (3) to obtain 2,200 psi pressure, stop the engine and remove the plug (fig. 100.1) from the clam close relief valve (3, fig. 99). Add or remove shims (see shim table on fig. 100.1) as required to obtain 2,200 psi. Replace the plug.

**Caution:** Before working the loader after adjusting the clam relief valves, make sure the main relief valve (4, fig. 99) is reset to the correct operating pressure of 2,000 psi. Refer to main relief valve major adjustment in subparagraph a.1, above.

Page 136. Figure 100 is superseded as follows:



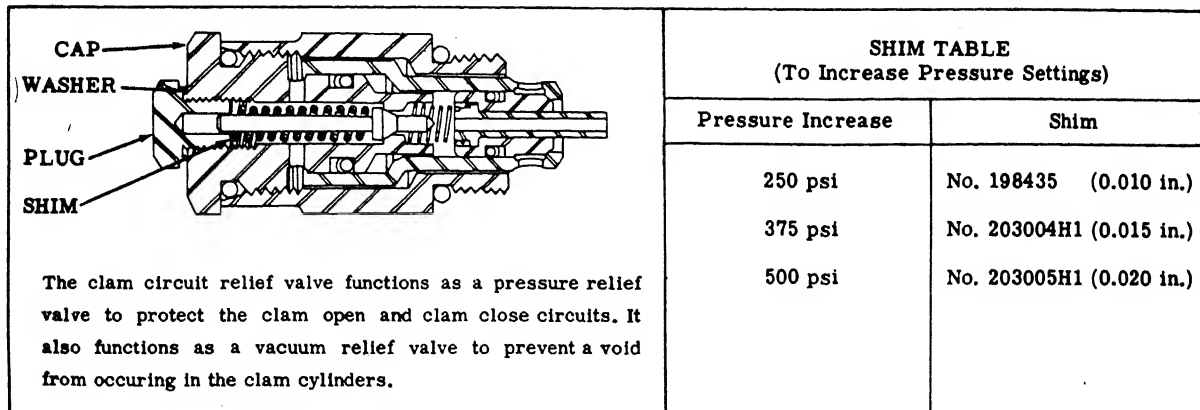
MEC 3805-201-15/100 C3

- 1 Adjusting screw cover
- 2 Jam nut
- 3 Adjusting screw
- 4 Inner adjusting nut
- 5 Pilot poppet
- 6 Pilot spring

- 7 Adjusting screw sleeve
- 8 Relief poppet
- 9 Poppet spring
- 10 End plug
- 11 Adjusting tool
- 12 Adjusting screw plug

Figure 100. Main relief valve adjustment.

Following figure 100 add:



MEC 3805-201-15/100.1 C3

Figure 100.1. Cross-sectional view of clam open and clam close relief valves.

Page 138. Following paragraph 212 add:

### 212.1 Periodic Transmission Check

**a. General.** To detect hydraulic malfunction of the transmission system before it can cause more serious failure, a periodic check and record of transmission operating pressures must be made and the results checked against readings made when the transmission was new. This check must also be made after a transmission is repaired or rebuilt. Make this check after every 500 hours of operation or semi-annually, whichever comes first. Make the check to coincide with transmission oil change, immediately after changing oil.

#### **b. Checking Procedure.**

- (1) Install three hydraulic pressure gages into ports in the transmission control valve as indicated in figure 103.1. Use a 0-300 psi gage to check transmission clutch pressure, a 0-50 psi gage to check lubricating oil pressure, and a 0-150 psi pressure gage to check converter pressure.
- (2) Start the engine and operate the loader long enough to warm the transmission oil to operating range as indicated by the torque converter oil temperature gage.
- (3) With the engine operating at low idle, check pressures indicated on pressure gages and record pressures.
- (4) Apply and hold brakes. Operate range shift lever to highest speed range. Operate directional shift lever to forward position. Watch tachometer and apply pressure on foot throttle until tachometer indicates 1,200 rpm. Hold speed at this lever and check and record gage readings.
- (5) Continue to hold brakes and, with transmission shifted as indicated in step (4) above, press foot throttle fully down until the tachometer indicates governed speed. Check and record gage readings.
- (6) For a new or rebuilt unit, the pressures must be within the following ranges for the various operating conditions.

	Clutch Oil Pressure (psi)	Lubricating Oil Pressure (psi)	Converter Oil Pressure (psi)
Low idle speed	150-220	3-10	5-20
1200 rpm stall	225-240	10-20	20-50
Maximum speed stall	225-240	25-40	35-70

- (7) Do not disconnect gages. Additional pressure checks may be required to localize troubles.

c. *Checkout Analysis.* As the transmission becomes older and starts to wear, the low idle speed pressures will drop progressively. Sometime later the stall pressures will start to drop and will drop progressively. These are normal indications. However, watch carefully for abnormally rapid changes or for localized changes that indicate that something is going wrong. The pressure drop pattern will help isolate the cause of the trouble as follows:

*Caution:* Perform only those repairs that are authorized at this level of maintenance. If the trouble indicated is not within the scope of first and second echelons of maintenance, report the trouble to the proper authority.

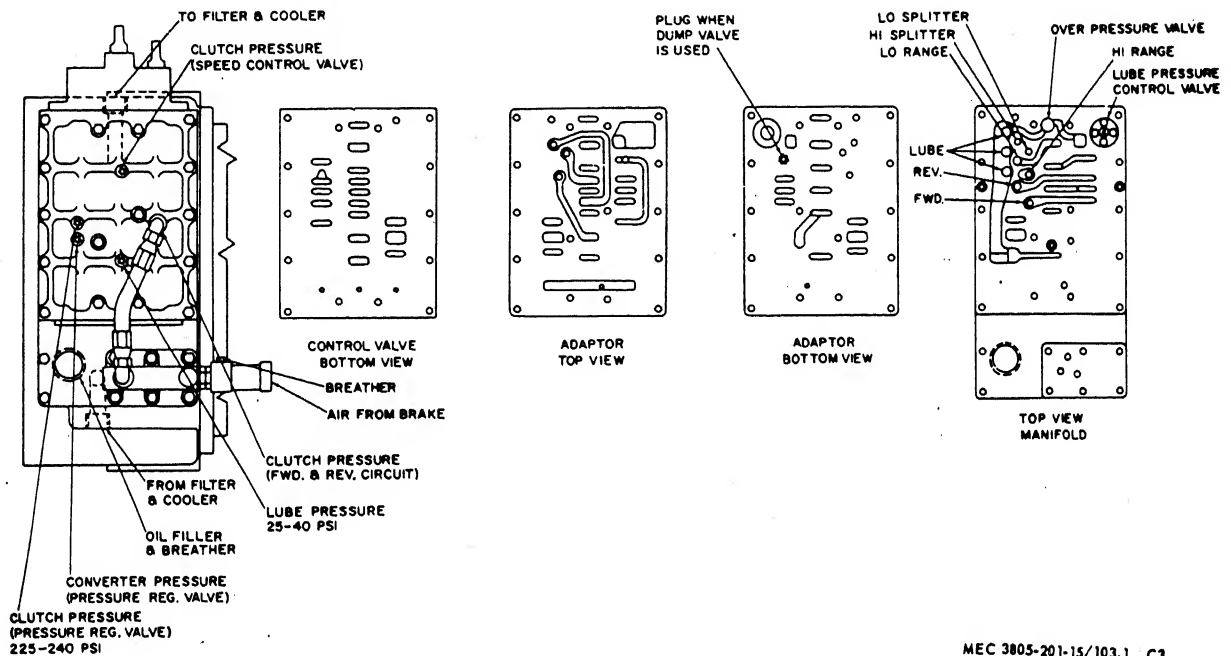
- (1) If all pressures drop, the trouble is probably caused by a clogged suction screen, a worn pump, a loose suction tube, or a sheared pump shaft.
- (2) If clutch pressures only drop, the trouble is probably due to sticking in the high pressure regulator, simultaneous leakage in high and low range clutch circuits, or simultaneous leakage in the high and low splitter circuits.
- (3) If clutch pressures are the same as converter pressures, the high pressure regulator is probably stuck open.
- (4) If clutch pressures are above normal, the high pressure regulator is probably stuck closed.
- (5) If clutch pressures appear erratic, the high pressure regulator is probably sticking momentarily. Observe pressures while increasing and decreasing engine speed.
- (6) If clutch pressure drops or equals lubricating oil pressure in either forward or reverse, dump valve is probably stuck open.
- (7) If both lubricating oil pressures and converter oil pressures drop but clutch pressures remain normal, the lubricating oil pressure regulator is probably stuck, oil tubes are loose, converter oil control rings are worn, expansion plugs in shafts are loose, or the converter has internal leaks.
- (8) If lubricating oil pressure is high and converter pressure is low, the overpressure valve is probably stuck open.
- (9) If converter pressures increase, the filter or oil cooler may be clogged or the hoses deteriorated internally, preventing free oil passage.
- (10) If the clutch pressure drop is localized, determine the pattern at which the low pressures occur by shifting to various speed and direction positions while making pressure checks as follows:

<i>Control Position</i>	<i>Leaking Clutch Circuit</i>
F-1, F-2, F-3, F-4-----	Forward
R-1, R-2, R-3, R-4-----	Reverse
F-1, F-2, N-1, N-2, R-1, R-2---	Low Range
F-3, F-4, N-3, N-4, R-3, R-4---	High Range
F-1, F-3, N-1, N-3, R-1, R-3---	Low Splitter
F-2, F-4, N-2, N-4, R-2, R-4---	High Splitter

- (11) When the leaking circuit is localized, the trouble in the circuit is probably caused by worn piston seals, worn oil control rings, or loose tubes in that circuit. Make sure, however, that transmission linkage allows the transmission spools to be shifted fully into the detents. Check that the control valve is not worn and is the cause of trouble. Control valve wear and leakage is checked by moving the spool in either direction from the detented position while operating the engine and checking the clutch pressure gage. If the pressure change is gradual as the spool is slowly moved, valve wear is probable. If the pressure change is abrupt, the valve is functioning properly.



Page 139. Following figure 103 add:



MEC 3805-201-15/103.1 C3

Figure 103.1. Transmission control valve, showing location of pressure checking ports.

Page 144. Section XVII, title is superseded as follows:

### Section XVII. BUCKET, FORK LIFT AND BOOM

Following paragraph 218b, add:

c. The fork lift is an hydraulically operated attachment capable of lifting 10,000 lbs. It can be raised or lowered with the boom control lever and tilted forward or backward with the bucket and accessory control lever. The fork lift is used to pick up, move or deposit solid loads.

Page 145. Following paragraph 219 add:

#### 219.1 Fork Lift

##### a. Removal.

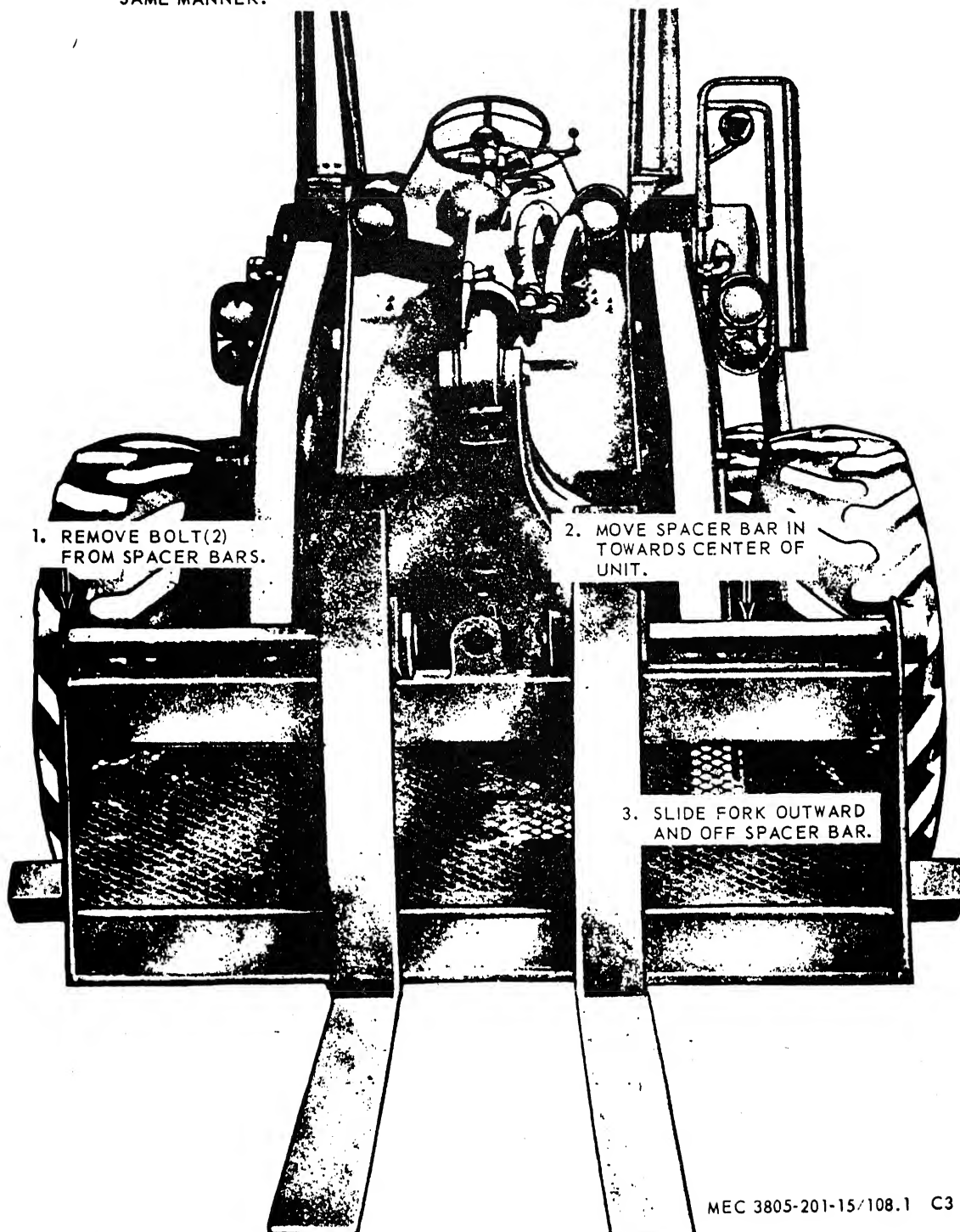
- (1) Place a solid block of approximate thickness of 2 inches under each end of carrier.
- (2) Lower the carrier until the base rests on the prepositioned blocks. Place all controls in their neutral positions and shut down engine.
- (3) Disconnect the hydraulic tubes (18 and 25, fig. 97) from the swivel connectors (20) and plug the openings.
- (4) Remove the swivel connectors and pinlocks (33, fig. 109).

**Caution:** The swivel connectors must be removed while removing the pinlocks. Keep swivel connectors clean.

- (5) Refer to figure 108.1 and remove the fork.
- (6) Remove the carrier from the loader.
  - (a) Attach chain hoist of 2 ton capacity to the carrier.
  - (b) Remove pinlocks (24, fig. 109) that secure links (22) to the fork lift.
  - (c) Remove pinlocks (33) that secure fork lift carrier to the boom.

**Page 147.** Following figure 108 add:

**NOTE:** THE FORKS WEIGH 360 POUNDS EACH. USE A ROLLER OR SUITABLE LIFTING DEVICE WHEN REMOVING FORKS CARRIER. BOTH FORKS ARE REMOVED IN SAME MANNER.



**Figure 108.1.** Forks, removal and installation. (Serial nos. 27MC-1778 through 27MC-1927).

Page 148 Section XVIII is added as follows:

### Section XVIII. OVERHEAD GUARD AND COUNTERWEIGHTS

#### 221.1 General

a. The loader, when used as a fork lift, has been provided with an overhead guard for the operator's protection and two 1,000 lb counterweights.

b. If the loader is to be equipped with a bucket, the overhead guard and the two 1,000 lb counterweights must be removed. The loader should never be operated with the bucket until the overhead guard has been removed.

#### 221.2 Overhead Guard

a. *Removal.* Refer to figure 109.1 and remove overhead guard.

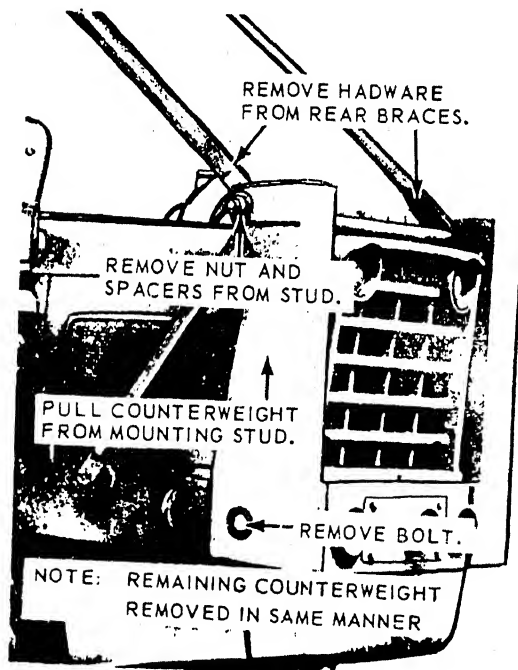
b. *Installation.* Install overhead guard by reversing order of removal.

#### 221.3 Counterweights

a. *Removal.* Refer to figure 109.1 and remove counterweights.

b. *Installation.* Install counterweights by reversing order of removal.

Following figure 109 add:



A. REAR END DETAIL

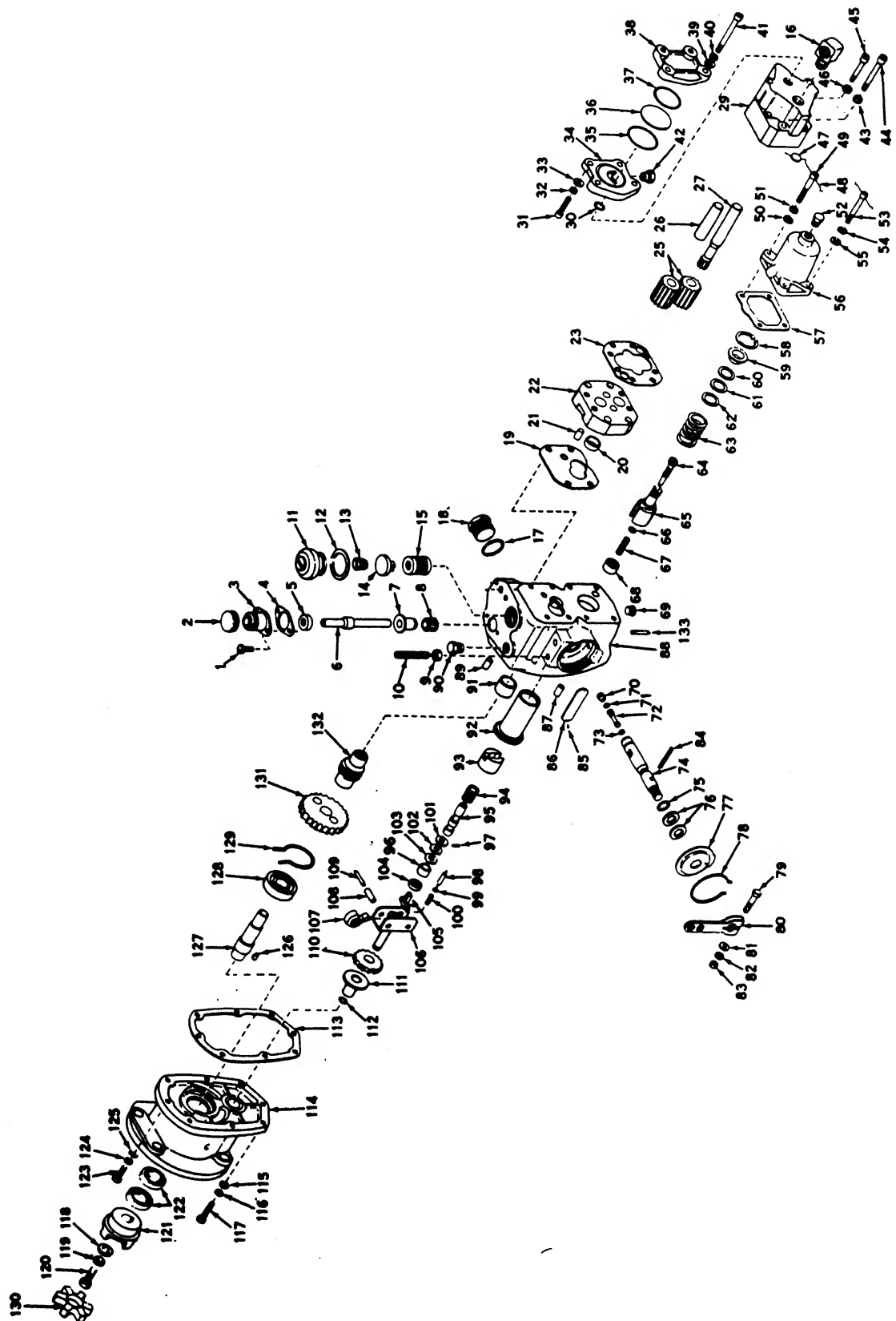


B. FRONT END DETAIL

MEC 3805-201-15/109.1 C3

Figure 109.1. Overhead guard and counterweights, removal and identification (Serial nos. 27MC-1778 through 27MC-1927).

Page 184. Figure 160 is superseded as follows:



MEC 3805-201-15/160 C3

Figure 160. Fuel pump, exploded view.

**Page 185.** Legends for figure 160, delete items 24 and 28.

Legends for figure 160, change item 93 as follows:

"93 Barrel"

Legends for figure 160, add item 133 as follows:

"133 Governor barrel clip (only serial nos. 27MC-1501 through 27MC-1927 and 27MC-2013 through 27MC-2702)"

**Page 186.** Paragraph 238c (6) is deleted in its entirety.

Following Paragraph 238c (7), add:

(7.1) Check and, if necessary, replace the governor drive plunger (95) and plunger barrel (93) as follows:

- (a) Check the fit of the governor drive plunger (95) in the plunger barrel (93). If the parts are worn, replace the plunger with a class 1 or 2 larger plunger. Lap to fit with No. 80 fine grit lapping compound.
- (b) If the barrel is worn too large for a class 7 plunger, heat the housing in boiling water for 1 1/2 to 2 minutes. On loaders with serial numbers 27MC-1501 through 27MC-1927 and 27MC-2013 through 27MC-2702, remove the governor barrel clip (133), using a wire hook, and reheat the housing. Press out the barrel.

*Caution:* On serial numbers 27MC-1501 through 27MC-1927 and 27MC-2013 through 27MC-2702, the housing will be damaged if the governor barrel housing clips are not removed before pressing out the barrel.

- (c) Check the barrel bore in the housing to determine whether a standard barrel (1.5020 to 1.5015 inch outside diameter) or a 0.010 inch or 0.020 inch oversize barrel is required. A minimum of 0.001 inch interference fit is required.
- (d) Scribe a centerline on the face of the governor barrel and in the housing to align fuel passages. Heat the housing in boiling water for 3 minutes. Cool the barrel in dry ice.
- (e) Position the spring pack housing (56) in place on the housing. Coat the outside diameter of the barrel with lubriplate, line up the scribe marks on the barrel and housing, and press the barrel into place. Install new barrel retaining clips, using cummins clip installation tool ST-853.
- (f) Select a new class 2 (green color code) plunger and attempt to insert it into the barrel. If the plunger enters, try a class 3 (yellow) plunger. Continue to insert new, larger class plungers until one is found that will not fit into the bore (see chart below). Then select a plunger two sizes smaller for use. Brush the plunger lightly with crocus cloth.

### GOVERNOR PLUNGER COLOR CODES

<i>Code</i>	<i>Red</i>	<i>Blue</i>	<i>Green</i>	<i>Yellow</i>	<i>Brown</i>	<i>Black</i>	<i>Gray</i>	<i>Purple</i>
<b>SIZE</b>	0	1	2	3	4	5	6	7
<b>PART NO.</b>	169660	169661	169662	169663	169664	169665	169666	169667

*Page 187.* Figure 166 is deleted.

Figure 167 is deleted.

*Page 200.* Paragraph 244, after title, add:

**Serial Nos. 27MC-1001 through 27MC-1406 and 27MC-1501 through 27MC-1927).**

*Page 202.* Figure 174, caption; add:

*(Serial nos. 27MC-1001 through 27MC-1406 and 27MC-1501 through 27MC-1927).*

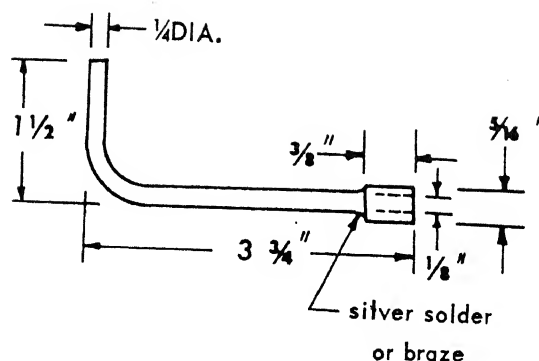
Following figure 174 add:





- 1 Nut
- 2 Lockwasher
- 3 Nut
- 4 Jumper
- 5 Screw
- 6 Setscrew
- 7 Sealing nut
- 8 Contact housing
- 9 Guard washer
- 10 Insulation washer
- 11 Insulation bushing
- 12 Contact stud assembly
- 13 Sealing ring
- 14 Insulation washer
- 15 Guard washer
- 16 Bushing insulation
- 17 Jumper
- 18 Gasket
- 19 Screw
- 20 Front plate
- 21 Oil seal
- 22 Roll pin
- 23 Guard washer
- 24 Spring
- 25 Shaft and snap ring assembly
- 26 Roll pin
- 27 Insulation washer
- 28 Special guard washer
- 29 Contact assembly
- 30 Spring contact
- 31 Special guard washer
- 32 Bushing
- 33 Armature support pin
- 34 Armature spring
- 35 Return bracket
- 36 Cup
- 37 Armature
- 38 Nut
- 39 Nut
- 40 Lockwasher
- 41 Guard washer
- 42 Insulation washer
- 43 Sealing ring
- 44 Screw
- 45 Insulator and terminal assembly
- 46 Insulation bushing
- 47 Gasket
- 48 Yoke
- 49 Screw
- 50 Magnet coil assembly
- 51 Shell assembly
- 52 Return spring
- 53 Plunger sleeve
- 54 Plunger and guide assembly
- 55 Nut
- 56 Screw
- 57 Band assembly
- 58 Brush
- 59 Screw
- 60 Noze housing
- 61 Plug
- 62 Felt wick

- 63 Bushing
- 64 Sealing plug
- 65 Preformed packing
- 66 Thrust (steel) washer
- 67 Screw
- 68 Lockwasher
- 69 Shift housing
- 70 Armature assembly
- 71 Thrust (fiber) washer
- 72 Oil seal
- 73 Thrust (fiber) washer
- 74 Thrust (steel) washer
- 75 Thrust (fiber) washer
- 76 Thrust (steel) washer
- 77 Preformed packing
- 78 Preformed packing
- 79 Screw
- 80 Washer
- 81 Preformed packing
- 82 Shift and lever shaft
- 83 Lever arm assembly
- 84 Drive assembly
- 85 Cotter pin
- 86 Roll pin
- 87 Coupling
- 88 Shaft and insert assembly
- 89 Bushing
- 90 Screw
- 91 Lockwasher
- 92 Housing
- 93 Preformed packing
- 94 Screw
- 95 Lockplate
- 96 Brush holder jumper
- 97 Screw
- 98 Lockwasher
- 99 Guard washer
- 100 Insulation bushing
- 101 Insulation washer
- 102 Brush holder assembly
- 103 Nut
- 104 Lockwasher
- 105 Guard washer
- 106 Lead assembly
- 107 Guard washer
- 108 Jumper and screw assembly
- 109 Insulation bushing
- 110 Sealing ring
- 111 Plug
- 112 Bushing
- 113 Bushing
- 114 Pole piece screw
- 115 Pole piece
- 116 Coil and jumper assembly
- 117 Screw
- 118 Guard washer
- 119 Sealing ring
- 120 Insulation bushing
- 121 Insulator
- 122 Insulation bushing
- 123 Field ring



MEC 3805-201-15/174.2 C3

Figure 174.2. Solenoid switch removal tool. (Serial nos. 27MC-2013 through 27MC-2702).

Page 203. Figure 175, after caption, add:

(Serial nos. 27MC-1001 through 27MC-1406 and 27MC-1501 through 27MC-1927).

Page 206. Following paragraph 244e, (2) add:

#### 244.1 Starting Motor and Solenoid Switch

a. *General.* The starting motor is a 24 volt, water-resistant unit which has a waterproof solenoid switch and an overrunning clutch drive. When the ignition switch is turned to START, the pull-in and hold-in coils of the solenoid switch are simultaneously energized and pull in the solenoid plunger. The solenoid plunger is connected through a linkage to a lever arm assembly which shifts the pinion of the overrunning clutch into engagement with the ring gear of the engine. As the parts mesh, the solenoid switch closes a set of electrical contacts which energize the starting motor, causing the overrunning clutch drive to rotate the engine ring gear which turns over the engine. When the drive is fully engaged, the pull-in windings are deenergized and the hold-in windings hold the drive engaged to the ring gear. When the engine starts so that the speed of the ring gear exceeds the driven speed of the starting motor, the overrunning clutch pulls free of the ring gear and the pinion runs freely until the ignition switch is returned to the RUN position. When the switch is restored to the RUN position, the drive returns to the AT REST position by the action of the spring in the solenoid which was compressed as the switch was energized.

##### b. *Removal and Disassembly.*

- (1) Remove the starting motor from the engine as directed in paragraph 141b.
- (2) Disassemble the starting motor following the sequence of index numbers assigned to the parts in the exploded view illustration in figure 174.1.
- (3) After removing the setscrew (6) from the solenoid switch, insert the specially designed tool (fig. 174.2) in the setscrew hole so that it engages the flattened end of the shaft (25, fig. 174.1). Turn it counterclockwise so that it is released from the switch plunger. This releases the solenoid switch from the shift linkage so that the switch can be removed as an assembly.
- (4) When removing brushes (58) from the starting motor, do not lift them out by the pig-tails.

- (5) To remove the shift shaft (82), remove the screw (79) and washer (80) from the shift housing (69). Turn the screw (79) into the end of the shaft (82) and pull the shaft out with a pliers. Rotate the shaft clockwise to facilitate removal.

*c. Cleaning and Inspection.*

- (1) Clean the solenoid switch, armature, field coils, and drive assembly with a cloth dampened in an approved cleaning solvent. Dry with clean, dry compressed air.

*Caution:* Do not immerse the drive assembly in cleaning solvent. The drive contains a special lubricant.

- (2) Clean all other metal parts thoroughly with cleaning solvent and wire brush where necessary.
- (3) Clean the insulators, insulating washers, insulated spacers, and brushes (if they are to be re-used) with a clean cloth.
- (4) Inspect the drive housing, commutator end housing, field ring and solenoid shell and brackets for cracks, breaks, damaged threads or other defects.
- (5) Check the armature for grounds with a 110-volt test light by touching one probe to a commutator bar riser and the other to the armature core. Test all commutator bars in this manner. If test light glows, the armature is grounded and must be replaced.
- (6) Check armature for short circuits with a growler. Place the armature in the growler, and hold a thin strip of steel such as a hacksaw blade about 1/32 inch to 1/16 inch away from the armature core. While holding the steel strip in position, rotate the armature slowly in the growler. A short circuit will pull the steel strip tightly against the armature core, and cause the strip to vibrate. If a short circuit is found, the armature must be replaced. Make test only after coils have been dried if they have been cleaned. With test lamp prods, one held on the field ring and the other on the field terminal, determine that the windings are not grounded to field ring or pole pieces. If the coils are shorted or grounded, remove and inspect if they can be reinsulated to eliminate the trouble. Replace coils if short or ground cannot be eliminated.
- (7) Inspect armature shaft alignment and commutator for eccentricity to shaft with a lathe, or "V" blocks, and a dial indicator. Check armature shaft for true alignment. If shaft run-out exceeds 0.005 inch, the armature must be replaced. If commutator eccentricity exceeds 0.003 inch, the commutator of the armature must be refinished. Minimum commutator diameter should be 2 1/16 inch. Minimum brush length should be 5/8 inch.
- (8) Clean minor burns or damage on the mating surfaces of the pinion housing with a fine mill file. If the bushing does not meet the allowable wear limits, remove it and replace with a new one. Press the bushing into position and ream to diameter of  $0.750 \pm 0.001$  inch.
- (9) If the commutator end housing bushing does not meet allowable wear limits, remove old bushing. When installing a new bushing, reposition the housing with the opposite side up and press the bushing in flush with the housing bore. Ream to a diameter of  $0.875 \pm 0.001$  inch.

*d. Reassembly and Installation.*

- (1) Reassembly is generally the reverse of disassembly. Refer to the exploded view illustration (fig. 174.1). Lubricate all preformed packings with glycerine during reassembly.
- (2) To install the switch, align the shaft (88) with the threaded hole in the plunger (54), making sure the nylon insert is installed in the shaft. Insert the special tool (fig. 174.2) through the access hole in the switch terminal housing and turn the shaft clockwise until it bottoms. Back off five turns and push the switch forward into the shaft housing. Align the mounting holes and secure the switch to the field ring with two screws (5).

- (3) Connect a 12-volt battery to switch terminals 1 and 4. With the solenoid switch energized, gently push the drive assembly back against the cams of the shift lever arm (83) and check the space between the face of the pinion and the thrust washer (66), using feeler gages of 0.187 inch thickness. If an adjustment is required, deenergize the solenoid switch and adjust with the adjusting tool. Energize the switch and recheck the adjustment.
- (4) Test the starting motor as directed in *e* below. After testing, install as directed in paragraph 141d.

*e. Testing.*

- (1) Manually rotate the armature shaft of the starting motor to assure that it is free. Connect a fully charged 12-volt battery and an ammeter in series with the terminal screw (117) and an unpainted portion of the field ring, making sure that a good electrical connection is attained. Use a tachometer to check motor speed. Current draw should be between 85 and 90 amperes and speed should be 3,800 rpm.
- (2) Check the hold winding resistance between terminal 1 and terminal 4 of the switch with an ohmmeter. Resistance should be 2.25 ohms. Check pull-in winding resistance between switch terminals 1 and 5 with an ohmmeter. Resistance should be 0.55 ohms.
- (3) Connect a jumper between terminals 4 and 5 of the switch. Connect a 24-volt battery and an ammeter in series with terminals 1 and 4 and check amperage. It should not exceed 53 amperes. Disconnect the jumper and check the amperage between terminals 1 and 4. Amperage should not exceed 10.0 amperes.
- (4) Reconnect a jumper between terminals 4 and 5. Connect a carbon pile rheostat and a 24-volt battery in series with terminals 1 and 4. Connect a voltmeter across the circuit. Use the rheostat to increase the battery output gradually until the solenoid coil pulls in. Check the pull-in voltage. It must not exceed 12 volts. Disconnect the jumper between terminals 4 and 5 and decrease the battery output with the carbon pile rheostat until the solenoid switch drops out. Check the drop-out voltage. It must be no more than 4 volts.

Page 220. Paragraph 252a, delete line 4 and replace with:

"control of the low air pressure switch), and, on loaders with serial numbers 27MC-1001 through 27MC-1406, also the."

Paragraph 252a, delete line 9 and replace with:

"cy brake coupling on loaders with Serial numbers 27MC-1001 through 27MC-1406, and to the air pressure gage of all loaders."

Page 221. Paragraph 252d, delete line 1 and replace with:

*d. Handbrake Valve* (Serial nos. 27MC-1001 through 27MC-1406 (fig. 185). The hand -.

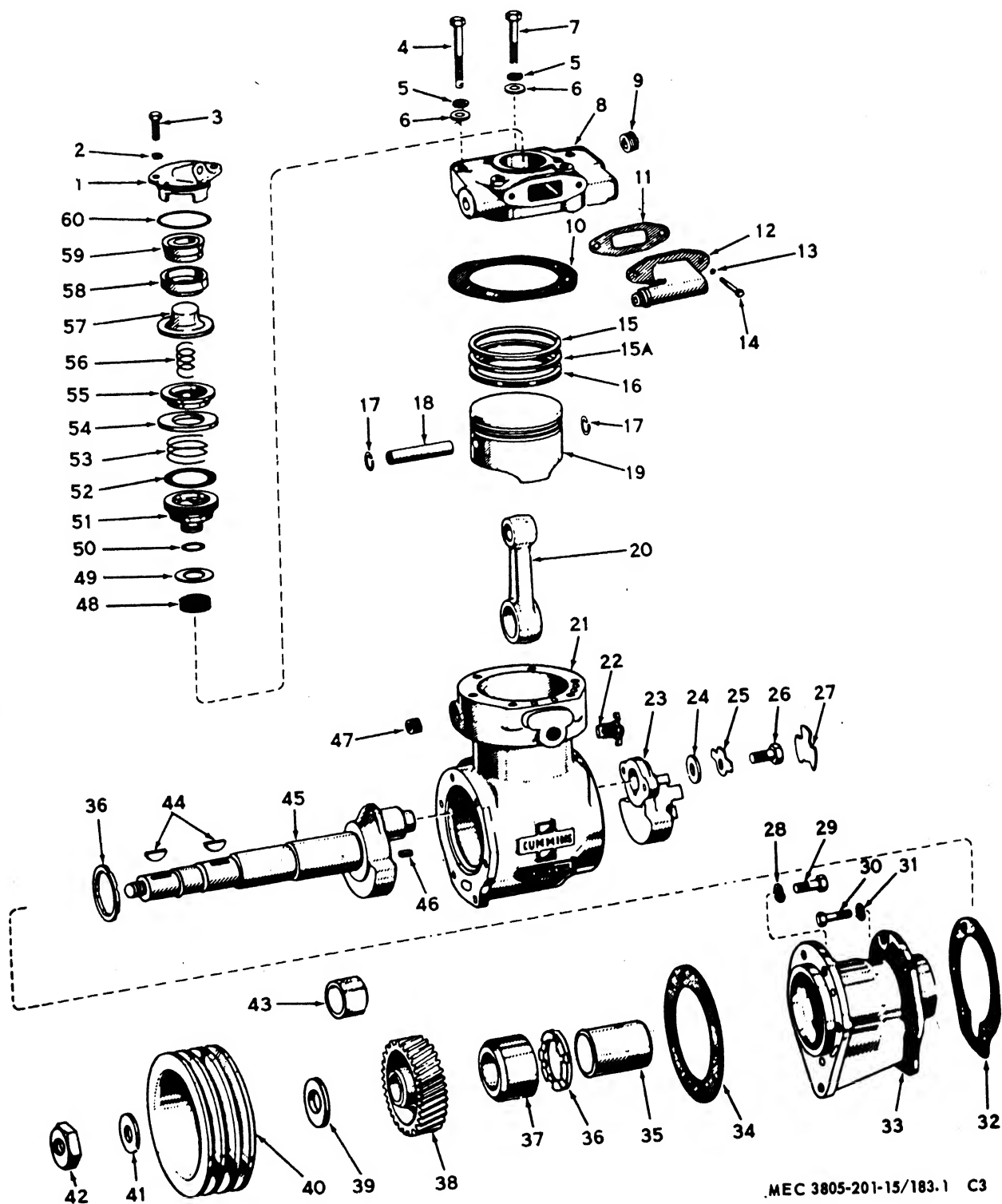
Paragraph 253. Change the title to read:

**253. Air Compressor (fig. 183 or 183.1)**

Page 222. Figure 183, following caption, add:

(Serial nos. 27MC-1001 through 27MC-1406).

Following figure 183 add:



- 1 Unloader valve body
- 2 Lockwasher
- 3 Capscrew
- 4 Capscrew

- 5 Lockwasher
- 6 Flat washer
- 7 Capscrew
- 8 Cylinder head

Figure 183.1. Air compressor, exploded view (Serial nos. 27MC-1501 through 27MC-1927 and 27MC-2013 through 27MC-2702).

- 9 Plug
- 10 Gasket
- 11 Gasket
- 12 Air inlet connection
- 13 Lockwasher
- 14 Capscrew
- 15 Piston ring, top
- 15A Piston ring, second
- 16 Piston ring, bottom
- 17 Retaining ring
- 18 Piston pin
- 19 Piston
- 20 Connecting rod
- 21 Crankcase
- 22 Draincock
- 23 Counterweight
- 24 Washer
- 25 Lockplate
- 26 Capscrew
- 27 Coupling retainer plate
- 28 Lockwasher
- 29 Capscrew
- 30 Capscrew
- 31 Lockwasher
- 32 Gasket
- 33 Support
- 34 Gasket

- 35 Bushing
- 36 Thrust bearing
- 37 Thrust sleeve
- 38 Accessory drive gear
- 39 Spacer
- 40 Pulley
- 41 Flat washer
- 42 Nut
- 43 Roller bearing
- 44 Key
- 45 Crankshaft
- 46 Key
- 47 Plug
- 48 Spring
- 49 Exhaust valve
- 50 Preformed packing
- 51 Exhaust valve seat
- 52 Preformed packing
- 53 Spring
- 54 Intake valve
- 55 Intake valve seat
- 56 Unloader valve spring
- 57 Unloader cap
- 58 Unloader cap guide
- 59 Unloader seat
- 60 Preformed packing

*Page 223.* Paragraph 253a (18), delete and replace with:

- (18) On loaders with serial numbers 27MC-1001 through 27MC-1406, remove the two compression piston rings (15, fig. 183) and oil ring (16) from the piston (19). On loaders with serial numbers 27M-C1501 through 27MC-1927 and 27MC-2013 through 27MC-2702, remove the top piston ring (15, fig. 183.1), second piston ring (15A) and the bottom or three-piece ring (16) from the piston. Remove the two retaining rings (17) and push the pin (18) from the piston.

*Page 224.* Paragraph 253e (7), delete and replace with:

- (7) On loaders with serial numbers 27MC-1001 through 27MC-1406, install the oil ring (16, fig. 183) and the two compression piston rings (15). On loaders with serial numbers 27MC-1501 through 27MC-1927 and 27MC-2013 through 27MC-2702, install the bottom or three-piece ring (16, fig. 183.1), the second ring (15A) and the top ring (15). Position the top or second rings so the word "top" or "press" stamped on the rings is to the top of the piston. On all loaders, make sure to observe the top markings and stagger the gaps of the compression rings.

*Page 225.* Paragraph 254, title, delete (fig. 184).

Paragraph 254a (2), delete the first line and replace with:

- (2) On loaders with serial numbers 27MC-1001 through 27MC-1406 and 27MC-1501 through 27MC-1927, remove the cotter pins (3, fig. 184) and push.

Following paragraph 254a (2) add:

- (2.1) On loaders with serial numbers 27MC-2013 through 27MC-2702, remove the cotter pins (2, fig. 184.1) and push out the pins (3) that secure the treadle to the mounting flange (10), and the roller (4) to the treadle.

Paragraph 254a (3), delete the first line and replace with:

- (3) On loaders with serial numbers 27MC-1001 through 27MC-1406 and 27MC-1501 through 27MC-1927, remove the push rod end (6, fig. 184) and nut.

Paragraph 254a (4), delete the first line and replace with:

- (4) On loaders with serial numbers 27MC-1001 through 27MC-1406 and 27MC-1501 through 27MC-1927, remove the boot (7, fig. 184) and treadle stop.

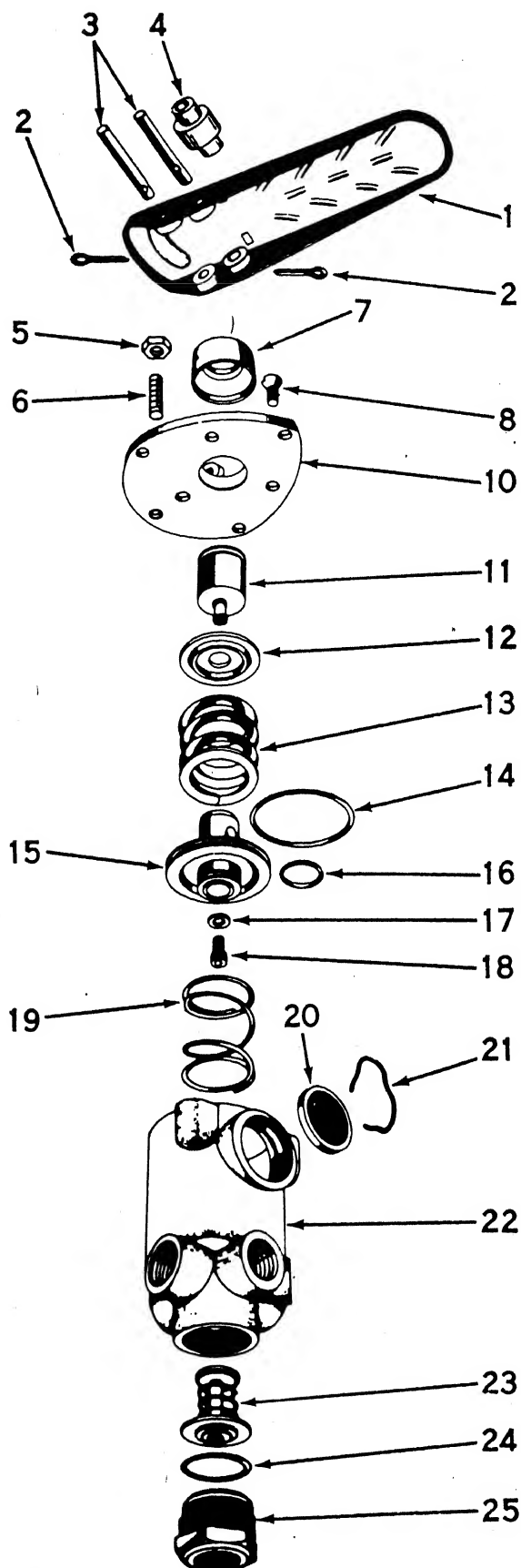
Following paragraph 254a (4) add:

(4.1) On loaders with serial numbers 27MC-2013 through 27MC-2702, remove the boot (7, fig. 184.1), jam nut (5), and setscrew (6) from the mounting flange (10).

*Page 226. Figure 184, following caption, add:*

*(Serial nos. 27MC-1001 through 27MC-1406 and 27MC-1501 through 27MC-1927).*

*Page 226. Following figure 184 add:*



- 1 Treadle
- 2 Pin, cotter
- 3 Pin
- 4 Roller
- 5 Nut
- 6 Screw
- 7 Boot
- 8 Screw
- 10 Mounting flange
- 11 Metering spring stem
- 12 Spring retainer
- 13 Metering spring
- 14 Preformed packing
- 15 Piston
- 16 Preformed packing
- 17 Washer
- 18 Screw
- 19 Spring
- 20 Filter
- 21 Lockwire
- 22 Valve body
- 23 Valve
- 24 Preformed packing
- 25 Inlet valve cap

Figure 184.1. Treadle valve, exploded view. (Series nos. 27MC-2013 through 27MC-2702).



Paragraph 254c (6), is superseded as follows:

- (6) On loaders with serial numbers 27MC-1001 through 27MC-1406 and 27MC-1501 through 27MC-1927, install the treadle stop button (9) and boot (7) on the mounting flange.

Paragraph 254c (7), delete the first line and replace with:

- (7) On loaders with serial numbers 27MC-1001 through 27MC-1406 and 27MC-1501 through 27MC-1927, position the push rod (4, fig. 184) on the.

Following paragraph 254c (7) add:

- (7.1) On loaders with serial numbers 27MC-2013 through 27MC-2702, position the roller (4, fig. 184.1) on the treadle (1); secure with a pin (3) and cotter pin (2). Install the boot (7), setscrew (6) and jam nut (5) on the mounting flange (10).

Paragraph 254c (8), is superseded as follows:

- (8) On loaders with serial numbers 27MC-1001 through 27MC-1406 and 27MC-1501 through 27MC-1927, position the assembled treadle and push rod on the mounting flange, inserting the push rod in the metering spring stem; secure with the remaining pin (2, fig. 184) and cotter pin (3).

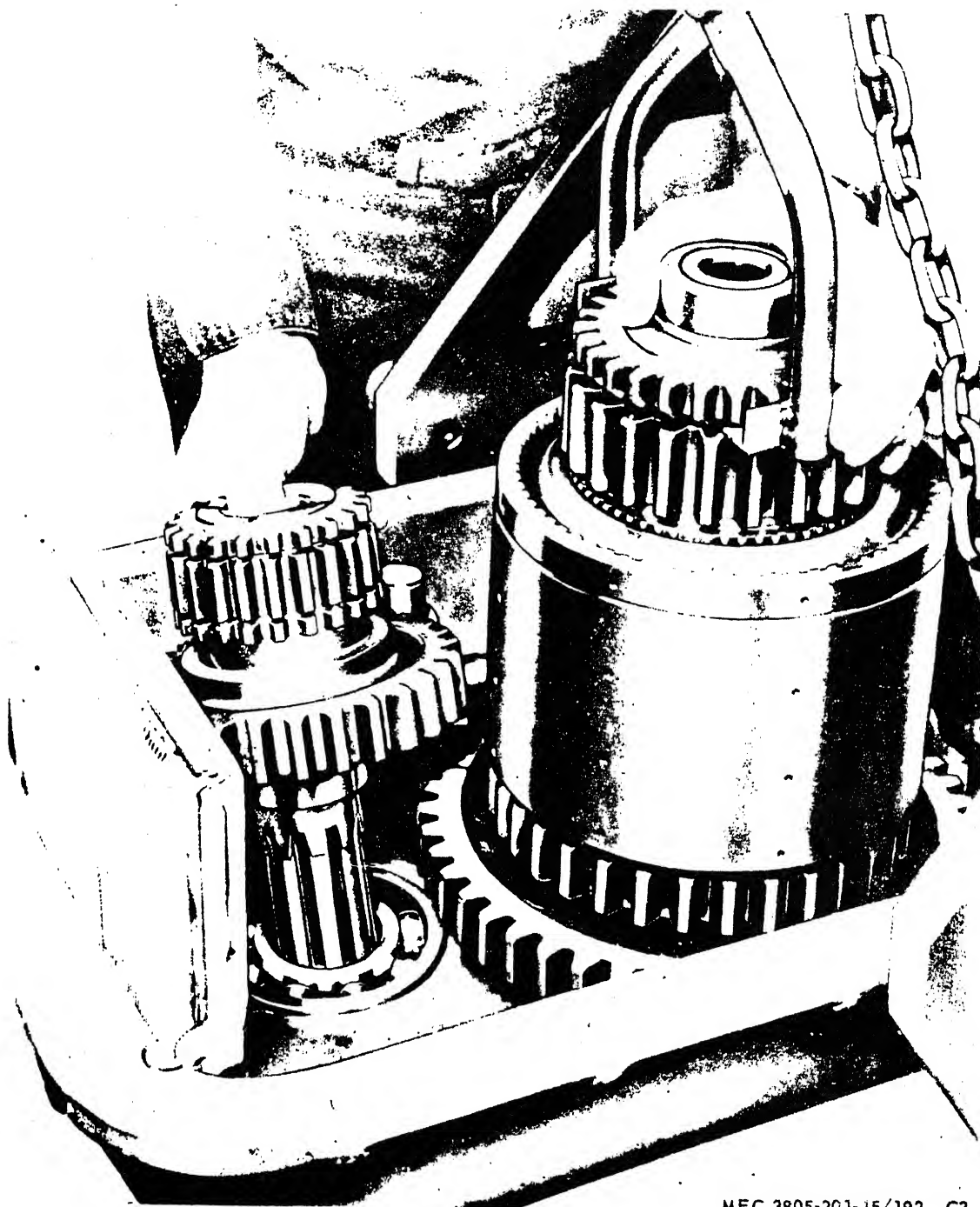
Following paragraph 254c (8) add:

- (8.1) On loaders with serial numbers 27MC-2013 through 27MC-2702, position 2013 through 27MC-2702, position the assembled treadle and roller on the mounting flange, with the roller resting on the metering spring stem; secure with the remaining pin (3, fig. 184.1) and cotter pin (2).

Paragraph 255, title change to read:

## **255. Handbrake Valve (Serial Nos. 27MC-1001 through 27MC-1406) (fig. 185).**

*Page 237.* Figure 192 is superseded as follows:



MEC 3805-201-15/192 C3

*Figure 192. Removing front output shaft assembly and splitter clutch.*

**Page 238.** Paragraphs 257c (3) (k) and (l) are superseded as follows:

- (k) Remove the forward and reverse clutch assembly (43, fig. 188).
- (l) Cut the lockwire (42) and remove the two capscrews (41) and washers (40) that secure the reverse idler gear (39) to the reverse idler shaft (101); lift the assembled reverse idler gear and bearing from its shaft.

Paragraphs 257c (3) (p) (q) and (r) are superseded as follows:

- (p) Remove the lockwire (19, fig. 193) and setscrew (18) that secure the shift fork (17) to the shift shaft (11); remove the shift fork and shift sleeve (26).
- (q) The front output shaft assembly and the splitter clutch assembly have overlapping gears which prevent their separate removal. Lift the splitter clutch assembly (45, fig. 188) while trapping the end of the front output shaft assembly.
- (r) When both the splitter clutch assembly and the front output shaft assembly have been raised sufficiently, tip the front output shaft assembly to one side and remove it from the housing as shown in figure 192. Remove the splitter clutch assembly.

Page 245. Paragraph 257e (3) (a), line 8, after "bares" add:  
"Retighten the screws twice with an impact tool and stake in place".

Page 246. Paragraph 257e (4) (e), is superseded as follows:

(e) To install the sleeve bearings (11) on the shaft, heat the bearings to 400°F and slide onto the shaft. Make sure the bearings bottom against the pistons.

Paragraph 257e (4), (j) is superseded as follows:

(j) Install the high-range gear (18); press the inner race of the roller bearing (19) on the splitter shaft assembly. Invert the shaft and position the low-range gear on the splitter shaft and install the inner race of the roller bearing (1) on the splitter shaft assembly.

Page 247. Paragraphs 257e (6) (e) and (f) are superseded as follows:

(e) The splitter clutch and front output shaft must be installed in the transmission case simultaneously because of overlapping gears. Make sure the outer race of the splitter clutch bearing is installed in the housing. Suspend the splitter clutch assembly over the housing and position the front output shaft assembly next to it as shown in figure 192.

Note. Use clean grease to hold the three piston rings centered during installation of each of the clutch assemblies.

(f) Start both assemblies into the housing at the same time. Lower the splitter clutch assembly while tapping the output shaft into place with a plastic mallet.

Page 248. Paragraph 257e (6) (i), delete note following the paragraph.

Paragraphs 257e (6) (j) and (k) are superseded as follows:

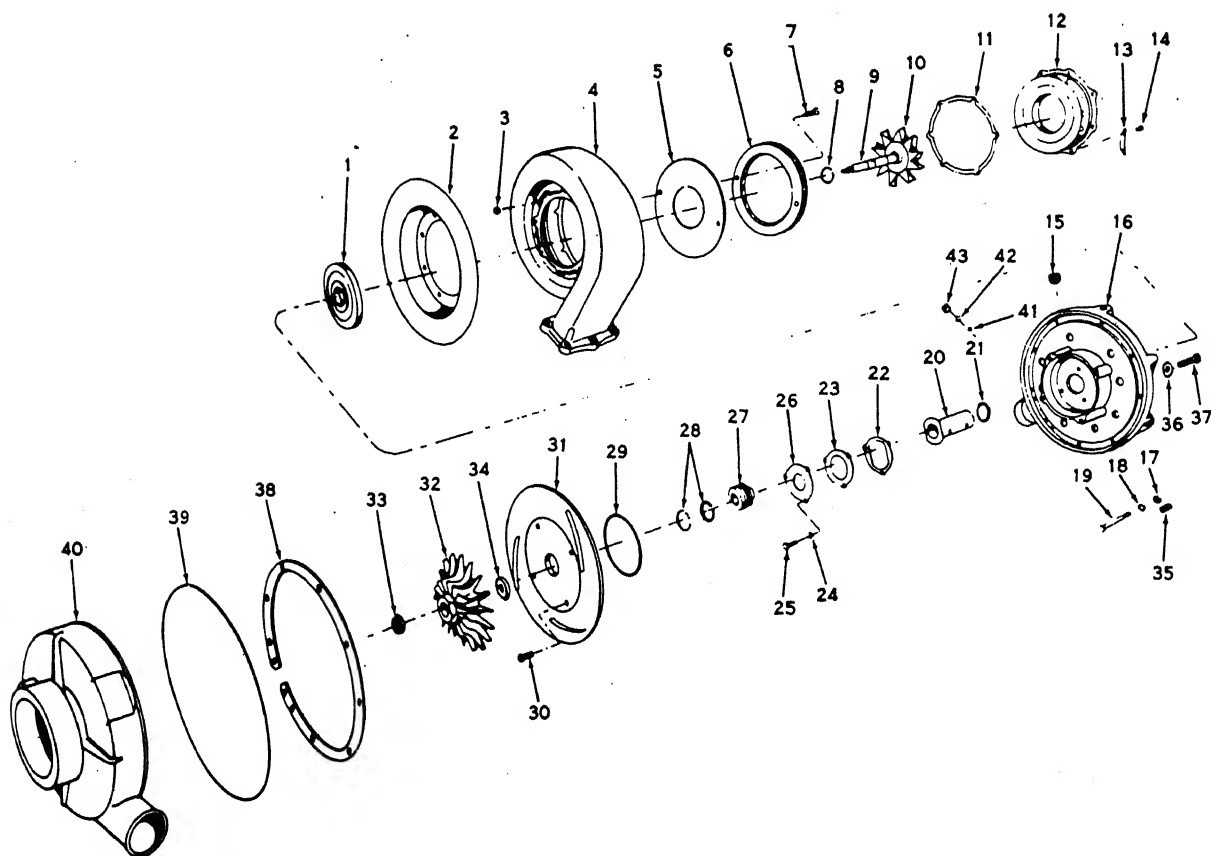
(j) Drive the bearing cone (36) on the reverse idler shaft (101), using a sleeve against the inner race of the cone. Position the reverse idler gear (39) on the shaft with the flat face toward the housing. Install one bearing shim on the shaft and install the second bearing cone (36). Secure the gear to the shaft with a washer (4) and two capscrews (41). Torque the capscrews to 16 to 18 foot-pounds. Use a dial indicator to check for end play of the gear. It must be between 0.001 and 0.005 inch. If necessary, add or subtract shims until the proper end play is obtained. When properly shimmed, tighten the capscrews to 16 to 18 foot-pounds and lockwire the capscrews.

(k) Install the forward and reverse clutch assembly (43) in the transmission housing.

Page 249. Paragraph 257e (7) (j), line 6, after "of" change "20 to 25" to read "23 to 26".

Paragraph 257e (7) (q), line 9, after "of" change "22 to 24" to read "26 to 29".

Page 282. Figure 219 is superseded as follows:



MEC 3805-201-15/219 C3

- |                      |                            |
|----------------------|----------------------------|
| 1 Oil seal plate     | 23 Thrust bearing spacer   |
| 2 Outer heat shield  | 24 Lockwasher              |
| 3 Nut                | 25 Screw                   |
| 4 Turbine casing     | 26 Outboard thrust bearing |
| 5 Inner heat shield  | 27 Oil seal sleeve         |
| 6 Nozzle ring        | 28 Piston ring seal        |
| 7 Screw              | 29 Preformed packing       |
| 8 Piston ring seal   | 30 Screw                   |
| 9 Rotor shaft        | 31 Diffuser plate          |
| 10 Turbine wheel     | 32 Compressor wheel        |
| 11 Shim              | 33 Nut                     |
| 12 Exhaust casing    | 34 Thrust washer           |
| 13 Lockplate         | 35 Pipe plug               |
| 14 Screw             | 36 Lockwasher              |
| 15 Plug              | 37 Screw                   |
| 16 Main casing       | 38 Retainer ring           |
| 17 Flat washer       | 39 Preformed packing       |
| 18 Lockwasher        | 40 Front plate             |
| 19 Screw             | 41 Orifice                 |
| 20 Floating bearing  | 42 Plug                    |
| 21 Preformed packing | 43 Oil inlet plug          |
| 22 Bearing retainer  |                            |

Figure 219. Turbocharger, exploded view.

Paragraphs 269b (3) and (4), are superseded as follows:

- (3) Remove the eight screws (37) and lockwashers (36) that secure the front plate retainer ring (38) to the main casing (16); remove the retainer ring and front plate (40). Remove the preformed packing (39).

- (4) Remove the nut (33) from the end of the rotor shaft (9); press the shaft from the compressor wheel (32). Remove the compressor wheel and the assembled turbine wheel (10) and rotor shaft (9). Remove the thrust washer (34).

Page 283. Paragraph 269b (7) is superseded as follows:

- (7) Remove the three screws (25) and lockwashers (24) that secure the outboard thrust bearing (26) to the main casing (16); remove the thrust bearing and thrust bearing spacer (23). Remove the floating bearing (20). Remove the preformed packing (21) from the bearing.

Paragraph 269b (9), is delete in its entirety.

Following paragraph 269b (11), add:

- (12) Remove the plugs (42 and 43) and the orifice (41) from the casing.

Paragraph 269c (8), line 5, after "less than" change "1.0308" to read "1.308".

Paragraph 269c (11) add:

- (11.1) Inspect the orifice for clogging and for worn or damaged threads.

Paragraph 269d (1) is superseded as follows:

- (1) Install the orifice (41) and plugs (42 and 43) in the main casing (16). Position the inner heat shield (5) in the turbine casing (4) with the concave area down the holes aligned with those in the casing.

Page 284. Paragraph 269d (8) is superseded as follows:

- (8) Install the preformed packing (21) in the floating bearing (20). Install the floating bearing in the main casing (16) with the hose toward the drain connection. Install the bearing retainer (22), thrust bearing spacer (23), and outboard thrust bearing (26) on the main casing; secure with three screws (25) and lockwashers (24), but do not tighten.

Page 285. Paragraphs 269d (20), (21), (22), and (23) is superseded as follows:

- (20) Assemble the front plate (40) and retainer ring (38). Position the assembled plate and ring on the main casing and secure with at least three screws (37). Invert the assembly and remove the exhaust casing (12). Use a depth indicator to register the end clearance of the rotor shaft, moving the rotor assembly from one end to the other. End clearance must be 0.014 to 0.025 inch.
- (21) Invert the assembly and remove the assembled front plate (40) and retainer ring (38); remove the nut (33) and press the compressor wheel on the rotor shaft until it bottoms. Install the nut (33), holding the rotor from turning with a wrench on the flats on the end of the shaft. Tighten the nut until snug. Advance the nut until the balance marks on the nut align with those on the shaft.

*Note:* In most cases, the compressor wheel will rub on the diffuser plate until the front plate is installed.

- (22) Install the retainer ring (38) and pre formed packing (39) on the front plate (40). Position the front plate and the assembled retainer ring on the assembly; secure with eight screws (37) and lockwashers (36). Tighten the screws to a torque of 84 inch-pounds. Make sure the rotor assembly rotates freely after installing the front plate.
- (23) Position the exhaust casing (12) on the assembly; secure with the lockplates (13) and screws (14). Torque the screws to 12 foot-pounds. Bend up the lockplate to retain the screws.

By Order of the Secretary of the Army:

HAROLD K. JOHNSON,  
General, United States Army,  
Chief of Staff.

Official:

KENNETH G. WICKHAM,  
Major General, United States Army,  
The Adjutant General.

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Engr FLDMS (2)  
Ft Knox, FLDMS (10)  
Fld Comd, DASA (8)  
AMS (3)  
USACOMZEUR (2)  
USAC (1)  
MAAG (1)  
JBUSMC (1)  
Army Attaches (1)  
Mil Man (1)  
Units org under fol TOE:  
(2 each UNOINDC)

5-35	7-100
5-36	10-7
5-37	10-106
5-48	10-107
5-64	10-458
5-107	10-475
5-115	10-477
5-117	17
5-118	17-100
5-127	29-1
5-145	29-5
5-147	29-11
5-155	29-16
5-157	29-17
5-177	29-21
5-195	29-26
5-197	29-27
5-237 (5)	29-36
5-262 (5)	29-37
5-267 (1)	29-65
5-278 (5)	29-79
5-279	29-215
5-500(EA,EB,EF)	29-217
6-415	37-100
6-419	44-235
6-435	44-237
6-439	44-535
6-445	44-537
6-449	77-100

NG: State AG (3).

USAR: Same as Active Army except allowance is one copy for each unit.

For explanation of abbreviations used, see AR 320-50.

CHANGE }  
No. 2 }

HEADQUARTERS  
DEPARTMENT OF THE ARMY  
WASHINGTON, D.C., 29 July 1966

**Operator, Organizational, Field and Depot Maintenance Manual**

**LOADER, SCOOP TYPE: DIESEL ENGINE; 4 WHEEL DRIVE, REAR WHEEL STEERABLE PNEUMATIC TIRES: 2½ CU YD; W/MULTI-SEGMENT BUCKET (FRANK G. HOUGH MODEL H-90CM) FSN 3805-995-3236**

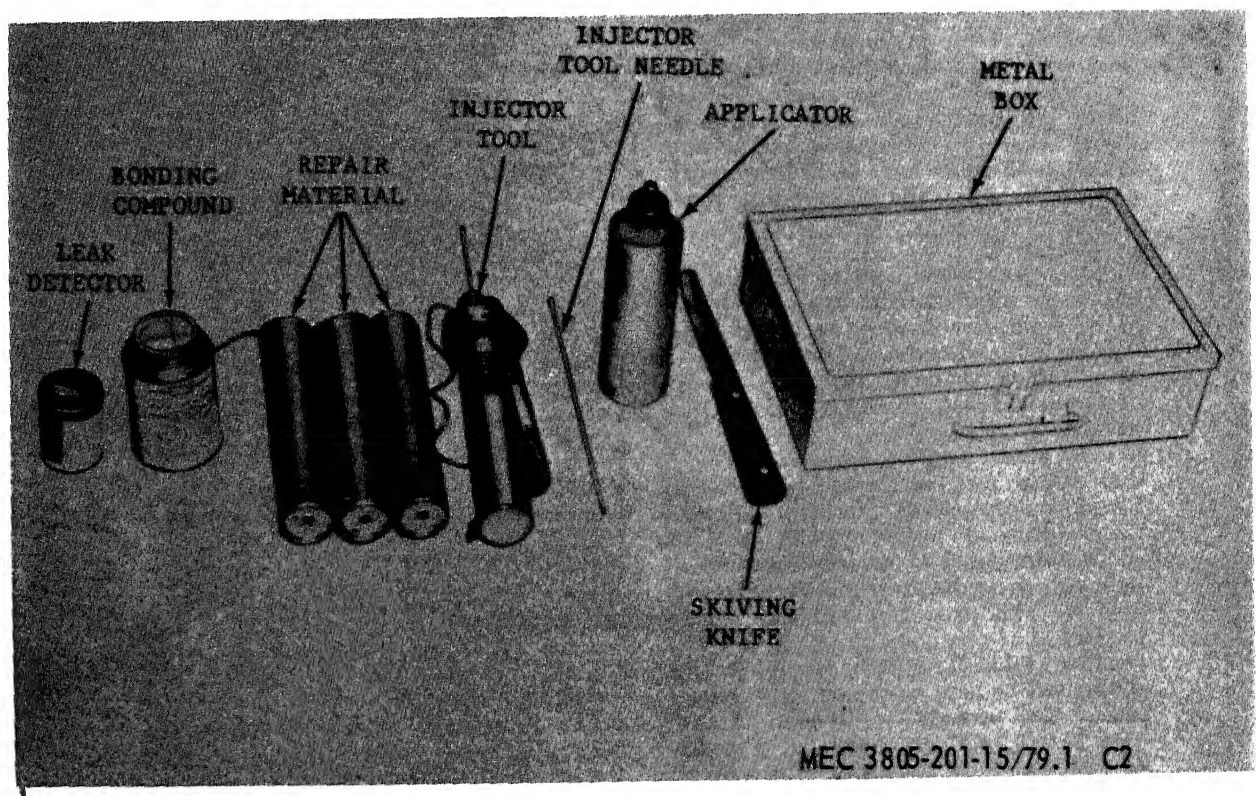
TM 5-3805-201-15, 24 February 1964, is changed as follows:

Page 4. Paragraph 1.  
c. (Superseded) Reporting of Equipment Manual Improvements. DA Form 2028 (Recommended Changes to DA publications) will be used for reporting discrepancies and recommendations for improving this manual. The form will be completed by the individual using the manual and forwarded direct to: Commanding General, U.S. Army Mobility Equipment Center, ATTN: SMOME-MPD, 4300 Goodfellow Blvd., St. Louis, Mo. 63120.

Page 111.

**177.1. Tubeless Tire Emergency Repairs**  
(Added)

a. General. The operator will make tubeless tire emergency repairs using a tubeless tire repair kit (fig. 79.1). The use of this tire repair kit will enable the operator to stop loss of air from a damaged tire. He can then inflate the tire to operating pressure, and continue operations. If he cannot stop the leak completely, he can retard loss of air from a damaged tire so that the bead does not break, and the operator can return to his



MEC 3805-201-15/79.1 C2

Figure 79.1. (Added) Tubeless tire repair kit.



base. Repairs will be made without removing the tire from the wheel and with air in the tire. There is no limitation to the size of the repair that can be attempted. The operator should periodically check tire air pressure because uneven inflation among tires may be an indication of tire damage.

*b. Locating Leak.*

- (1) Remove all mud and dirt from obvious or suspected damaged area of tire.
- (2) Refer to figure 79.1 and unscrew cap from applicator (plastic bottle).
- (3) Fill applicator cap with leak detector powder, pour into applicator, and fill applicator with water.
- (4) Replace cap and shake applicator to allow powder to dissolve.
- (5) Spray tire. Tiny white bubbles will show location of leak.
- (6) Remove weight from injured tire by transferring equipment weight to dozer blade or by any other available means.

*Note.* Be sure to check bead and valve for leaks.

*c. Probing Puncture.*

- (1) Remove all foreign objects (nails, glass, etc.) from puncture.
- (2) Refer to figure 79.1 and remove injector tool from kit; then grasp needle, and extend the needle 2 inches from needle holder. While moving needle, do not press on clamp lever since pressure on lever locks the needle in place.
- (3) Dip needle in bonding compound  $\frac{1}{2}$  inch.
- (4) Apply pressure on clamp lever and press needle into puncture to find direction of injury (fig. 79.2A). After extent and direction of injury have been determined, pull out needle while maintaining pressure on lever.

*d. Threading Needle.*

- (1) Unscrew cannister housing of injector tool from needle-holder base and place plastic cannister containing thread into housing with thread end facing up.
- (2) Pass end of material through hole in needle-holder base and screw base onto housing.
- (3) Extend needle length to 8 inches.
- (4) Pull repair material extending through hole at top of needle-holder base and pass material through needle eye (fig. 79.2B); continue until end of material reaches the point where needle protrudes from needle holder. This procedure provides a single strand of repair material suitable for repairs of small punctures. A double strand can be used to repair large punctures. To provide a double strand (fig. 79.2C), pull an additional 8 inches of material from cannister; the end of

material should reach the base of injector tool. Then, double material back on itself and thread it through the needle eye from the direction opposite that in single strand, until end of thread is at point where needle protrudes from needle holder.

*e. Injecting Thread Into Puncture.*

- (1) Retract needle to 2 inches after completing *d* above.
- (2) Dip needle with thread into bonding compound  $\frac{1}{2}$  inch.
- (3) Insert into puncture with steady pressure, following direction of puncture, until extended portion (2 inches) of needle is completely inserted. Be sure to squeeze tightly on clamp lever while inserting needle.
- (4) Release pressure on clamp lever and extend needle 2 inches more.
- (5) Continue inserting needle into tire in 2-inch increments until end of material is  $\frac{1}{2}$  inch from outside face of tire (fig. 79.2D).

**Caution.** The needle should be inserted in 2-inch increments to reduce the possibility of bending or breaking the needle.

*f. Withdrawing Needle.*

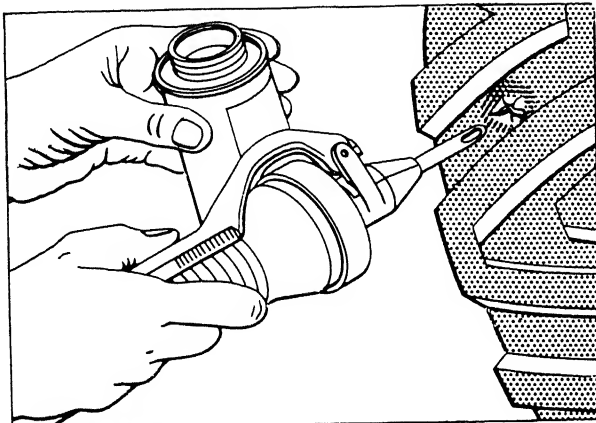
- (1) Squeeze clamp lever tightly and, with a steady pull, withdraw needle in 2-inch increments until end of needle is  $\frac{1}{2}$  inch from outside face of tire.
- (2) Cut material at eye of needle (fig. 79.2E).
- (3) Repeat *d* through *f*, if necessary, until puncture is repaired.
- (4) Test the repair with leak detector.
- (5) Cut material  $\frac{1}{4}$  inch from face of tire (fig. 79.2F).

*g. Inspecting Repair.* To insure that the leak is permanently sealed, the organizational mechanic will inspect the repair for three days. He will use the kit leak detector and will follow the procedure described in *b* (2) through (5). When a leak cannot be completely stopped, the tire should be removed and repaired by field maintenance personnel.

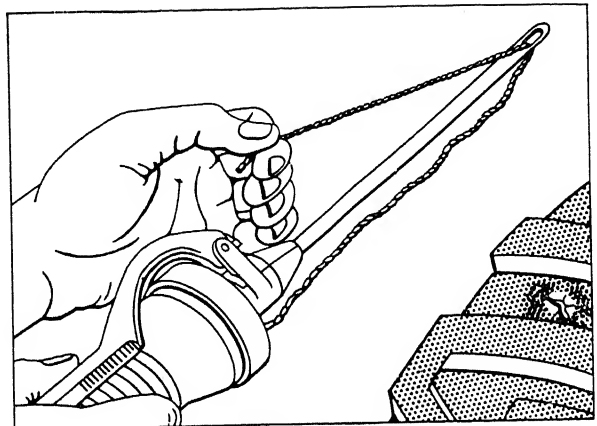
*Page 298.* (Maintenance Allocation Chart). Functional Group 1313. (Add) "Repair" in the components and related operation column, and an "X" in the 1st Echelons of maintenance column. In the Remarks column for the above addition, insert the following: On-vehicle tubeless tire emergency repairs.

*Page 299.* Immediately above Functional Group 43, Hydraulic System, insert the following: Functional Group 33, SPECIAL PURPOSE KIT; Functional Group 3307, Special Purpose Kits; Kit, repair, tubeless tire. Insert an "X" in the 1st Echelons of maintenance column.

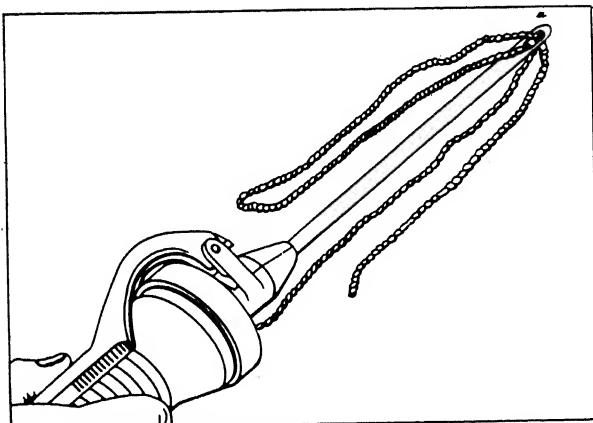




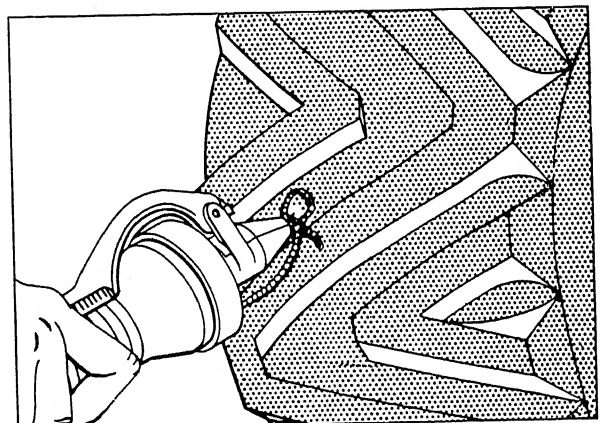
**A. PROBING PUNCTURE**



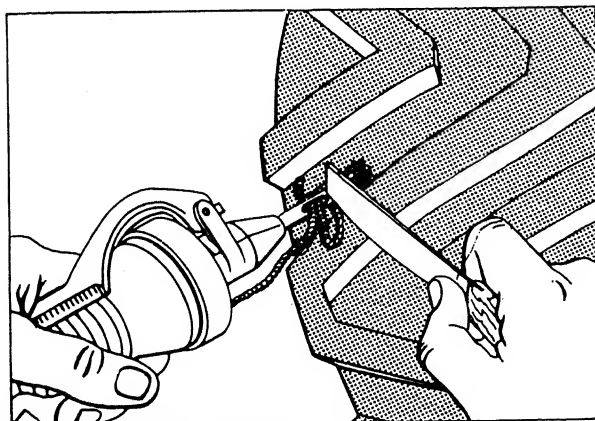
**B. THREADING NEEDLE, SINGLE STRAND**



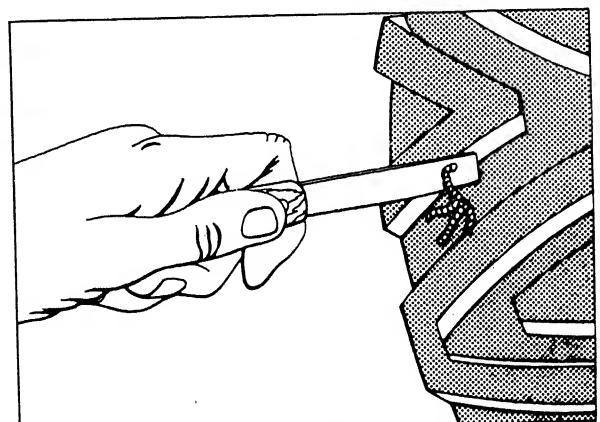
**C. THREADING NEEDLE, DOUBLE STRAND**



**D. THREAD INTO PUNCTURE**



**E. CUTTING THREAD**



**F. TRIMMING EXCESS THREAD**

MEC 3805-201-15/79.2 C2

*Figure 79.2. (Added) Tubeless tire repair kit operating instructions.*

Page 304. Insert the following immediately after 3200—Basic Issue Items, Troop Installed or Authorized.

Source codes				Federal stock No.	Description	Unit of issue	Quantity authorized	Quantity issued with equipment	Illustration	
Material	Source	Maintenance	Recoverability						Fig.	Item
-----	P	O	-----	4910-922-6921	Kit, Repair, Tubeless Tire-----	-----	1	1	79. 1	-----

By Order of the Secretary of the Army:

HAROLD K. JOHNSON,  
General, United States Army,  
Chief of Staff.

Official:

J. C. LAMBERT,  
Major General, United States Army,  
The Adjutant General.

Distribution:

*Active Army:*

USASA (2)	Army Dep (2) except TOAD (3)	5-278 (5)	7-11
ACSI (1)	USA Tml Comd (2)	5-279	7-12
DCSLOG (1)	Army Tml (1)	5-500 (EF,	7-100
CNGB (1)	Div Engr (2)	EG, HF,	10-7
TSG (1)	Engr Dist (2)	HQ)	10-105
CofEngrs (3)	USA Engr R&D Lab (3)	6-100	10-107
CC-E (1)	USAMEC (46)	6-155	10-458
Dir of Trans (1)	Engr Cen (5)	6-156	10-475
CofSptS (1)	USAREUR Engr Proc Cen (2)	6-165	10-477
USAMB (1)	USAREUR Engr Sup Con Agcy	6-166	17-100
USA Arty Bd (2)	(10)	6-300	29-1
USA Armor Bd (2)	Engr FLDMS (2)	6-315	29-5
USAIB (2)	Ft Knox FLDMS (10)	6-316	29-11
USARADBD (2)	Fld Comd, DASA (8)	6-328	29-16
USAAESWBD (2)	AMS (3)	6-345	29-17
USAAVNTBD (2)	USACOMZEUR (2)	6-346	29-21
USCONARC (3)	MAAG (1)	6-355	29-26
OS Maj Comd (5) except USARJ	JBUSMC (1)	6-356	29-27
(1)	Units organized under following	6-405	29-36
USASETAF (2)	TOE's (2 each) unless other-	6-406	29-37
USAMOCOM (2)	wise indicated:	6-415	29-65
USASMC (1)	5-5	5-117	29-79
USACDCEC (10)	5-6	5-118	29-215
MDW (1)	5-15	5-127	29-217
Armies (2)	5-16	5-129	29-407
Corps (2)	5-35	5-145	37-100
USAC (1)	5-36	5-147	39-61
Div (2)	5-37	5-155	44-235
Engr Bde (1)	5-45	5-157	44-237
USMA (2)	5-46	5-177	44-535
Svc Colleges (2)	5-8	5-214	44-537
Br Svc Sch (2) except USAES (3)	5-54	5-237 (5)	
Gen Dep (10)	5-64	5-262 (5)	
Engr Dep (10)	5-115	5-267 (1)	

NG: State AG (3).

USAR: Same as Active Army except allowance is one copy to each unit.

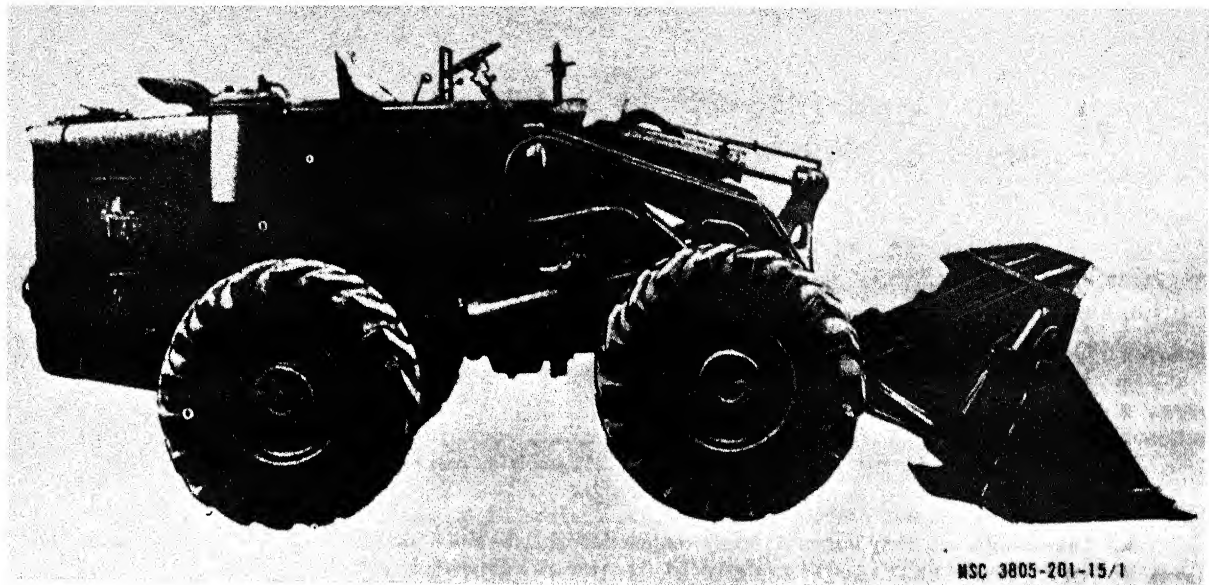
For explanation of abbreviations used see AR 320-50.

TECHNICAL MANUAL }  
No. 5-3805-201-15 }

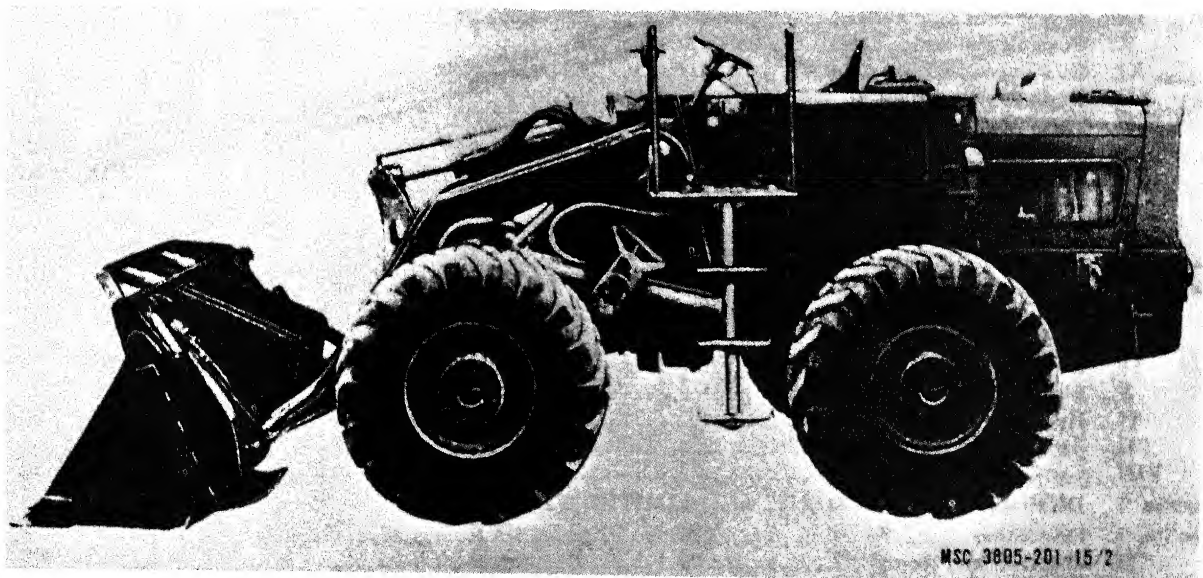
HEADQUARTERS  
DEPARTMENT OF THE ARMY  
WASHINGTON, D.C., 24 February 1964

**OPERATOR, ORGANIZATIONAL, FIELD, AND DEPOT MAINTENANCE MANUAL**  
**LOADER, SCOOP TYPE; DIESEL ENGINE, 4 WHEEL DRIVE, REAR WHEEL**  
**STEERABLE PNEUMATIC TIRES; 2½ CU YDS: W/MULTI-SEGMENT BUCKET**  
**(FRANK G. HOUGH MODEL H-90CM) FSN3805-995-3236**

	Paragraph	Page
<b>CHAPTER 1. INTRODUCTION</b>		
Section I. General.....	1, 2	3, 4
II. Description and data.....	3-5	4, 5
<b>CHAPTER 2. OPERATING INSTRUCTIONS</b>		
Section I. Service upon receipt of equipment.....	6-9	10-12
II. Controls and instruments.....	10-42	13-19
III. Operating details.....	43-46	19-26
IV. Operation under unusual conditions.....	47-52	28, 29
V. Operation of auxiliary material used in conjunction with the end item.....	53, 54	30
<b>CHAPTER 3. OPERATOR AND ORGANIZATIONAL MAINTENANCE INSTRUCTIONS</b>		
Section I. Special tools and lubrication.....	55-57	32
II. Preventive maintenance services.....	58-60	45
III. Troubleshooting.....	61-121	50-56
IV. Radio interference suppression.....	122-126	57, 58
V. Fuel system.....	127-135	58-60
VI. Electrical system.....	136-146	71-79
VII. Cooling system.....	147-152	80-86
VIII. Engine lubrication system.....	153-160	87-94
IX. Engine.....	161-167	94-99
X. Controls and instruments.....	168-175	99-108
XI. Chassis assembly.....	176-184	109-116
XII. Brake system.....	185-196	117-124
XIII. Steering system.....	197-202	125-130
XIV. Main hydraulic system.....	203-209	132-137
XV. Torque converter and transmission hydraulic system.....	210-214	138-140
XVI. Drive shafts.....	215-217	141, 142
XVII. Bucket and boom.....	218-221	144-147
<b>CHAPTER 4. FIELD AND DEPOT MAINTENANCE</b>		
Section I. General.....	222, 223	149
II. Engine overhaul.....	224-236	151-174
III. Fuel system.....	237-239	178-192
IV. Cooling system.....	240, 241	194, 195
V. Electrical system.....	242-244	195-200
VI. Hydraulic system.....	245-251	206-219
VII. Air system.....	252-256	219-220
VIII. Carrier repair instructions.....	257-269	232-281
<b>CHAPTER 5. DEMOLITION, SHIPMENT, AND LIMITED STORAGE</b>		
Section I. Demolition.....	270-274	286, 287
II. Shipment and storage.....	275-278	287, 288
<b>APPENDIX I. REFERENCES</b>		289
II. MAINTENANCE ALLOCATION.....		29
III. BASIC ISSUE ITEMS LIST AND MAINTENANCE AND OPERATING SUPPLIES.....		302
<b>INDEX</b>		307



*Figure 1. Loader, Model H-90GM, right side view.*



*Figure 2. Loader, Model H-90CM, left side view.*

# CHAPTER 1

## INTRODUCTION

### Section I. GENERAL

#### 1. Scope

a. These instructions are published for the use of the personnel to whom the Frank G. Hough Model H-90CM Scoop Type Loader is issued. Chapters 1 through 3 provide information on the operation, preventive maintenance services, and organizational maintenance of the equipment, accessories, and components. Chapter 4 provides information for field and depot

maintenance (3d, 4th, and 5th echelons). Chapter 5 provides information on demolition, shipment, and limited storage. Also, included are descriptions of main units and their functions in relationship to other components.

b. Appendix I contains a list of publications applicable to this manual. Appendix II contains the maintenance allocation chart. The maintenance allocation chart governs the echelon of

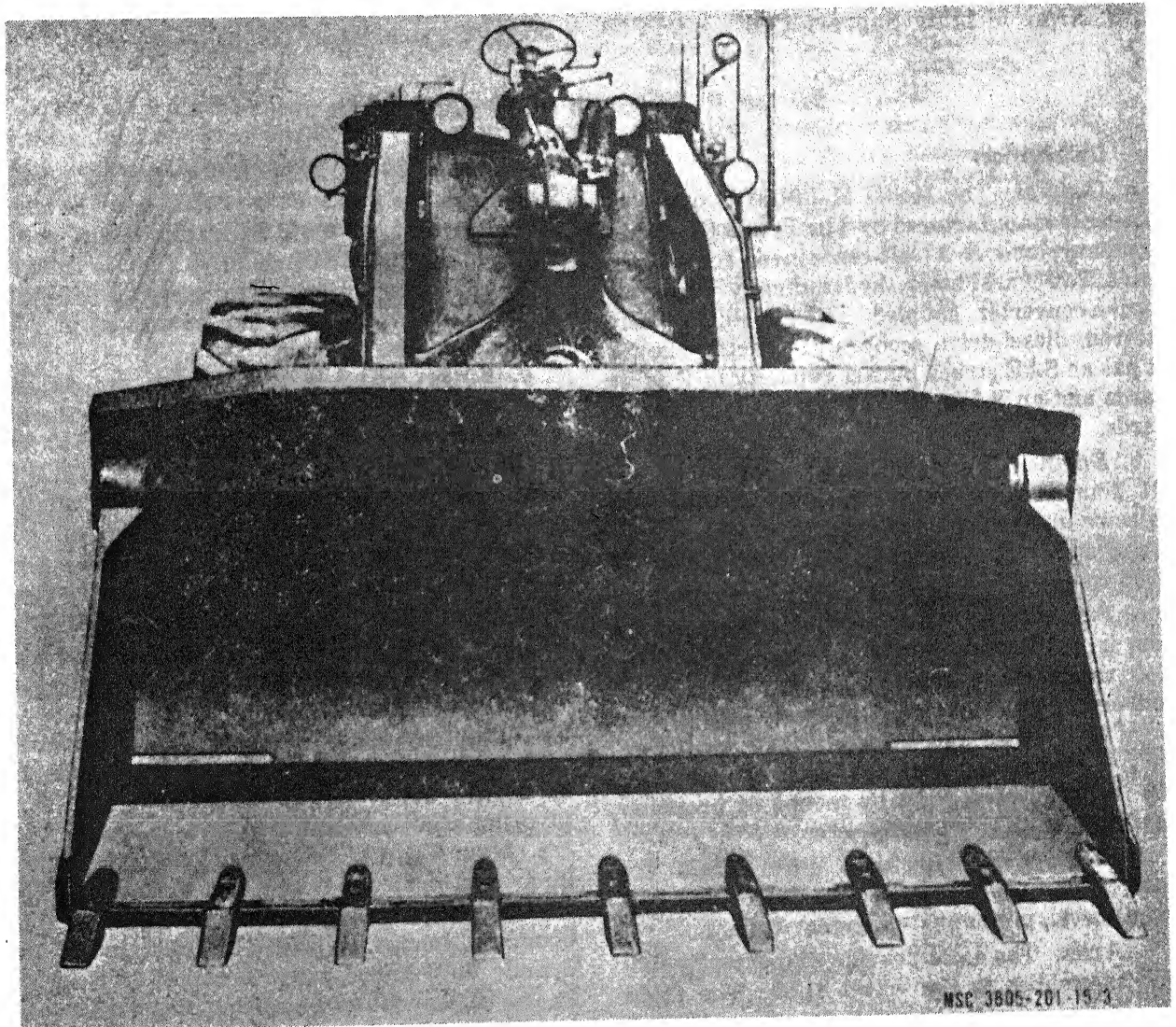


Figure 3. Loader, Model H-90CM, front view.



maintenance regardless of the placement in the text. Appendix III contains the list of basic issue items and maintenance and operating supplies authorized the operator of this equipment. Repair parts and special tool lists are contained in TM 5-3805-201-20P.

c. The direct reporting, by the individual user, of errors, omissions, and recommendations for improving this manual is authorized and encouraged. DA Form 2028 (Recommended Changes to DA Technical Manual Parts Lists or Supply Manual 7, 8, or 9) will be used for reporting these improvements. This form will be completed in triplicate, using pencil, pen, or typewriter. The original and one copy will be forwarded direct to the Commanding Officer, U. S. Army Mobility Support Center, ATTN:

SMOMS-MM, P. O. Box 119, Columbus, Ohio 43216. One information copy will be provided to the individual's immediate supervisor, (e.g., officer, noncommissioned officer, supervisor, etc.).

d. Report all equipment improvement recommendations as prescribed by TM 38-750.

## 2. Record and Report Forms

a. DA Form 2258 (Depreservation Guide of Engineer Equipment).

b. For other record and report forms applicable to the operator, crew, and organizational, field and depot maintenance, refer to TM 38-750.

*Note.* Applicable forms, excluding Standard Form 46 which is carried by the operator, will be kept in a canvas bag mounted on the equipment.

## Section II. DESCRIPTION AND DATA

### 3. Description

a. *General.* The Model H-90CM Scoop-type Loader is manufactured by The Frank G. Hough Company, and is a self-contained, four-wheel drive, two-wheel steer, hydraulically operated, torque-converter coupled, power shifted and steered, diesel-drive scoop-type tractor shovel. It has an SAE struck bucket capacity of 2 cubic yards and an SAE rated capacity of 2½ cubic yards.

b. *Engine.* The engine is a Cummins JT-6-B1 four-stroke-cycle, six-cylinder, valve and injector-in-head, water-cooled, turbocharged diesel engine that develops 162 horsepower at 2200 rpm.

c. *Transmission.* The power-shift transmission is a Rockwell-Standard Model BDB-213-C-2 transmission that incorporates a torque converter. It provides four speed ratios, forward or reverse, and can deliver two-wheel or four-wheel drive as required. It is connected to the front and rear axles by means of propeller shafts and universal joints.

d. *Differentials.* Identical differentials are used in the front and rear axles. They are spiral-bevel, pinion-and-ring-gear type.

e. *Axles.* The axles provide planetary reduction assemblies in the wheel hubs. The front axle is a rigid axle; the rear axle is a steering axle.

f. *Steering.* The mechanical steering gear is

power-assisted by the hydraulic steering system. The hydraulic pressure is provided by the steering section of the main hydraulic pump, and is metered by the steering valve that is integral with the steering gear. Two steering hydraulic cylinders are provided, one connected at each end of the steering axle.

g. *Brakes.* The service brakes are an air-over-hydraulic type in which air from the engine-mounted compressor is supplied to the brake power cluster to operate the hydraulic brake cylinders when the brake treadle valve is applied. The hydraulic brake cylinders are mounted within the wheels and actuate the internal expanding brake shoes at each wheel. The hand lever operated parking brake is an internal expanding shoe type which operates against the drum mounted on the transmission output shaft.

h. *Frame.* The frame is of welded construction, and is secured to the forward axle by stationary supports and to the rear axle by a pivoting cradle assembly.

i. *Main Hydraulic System.* The main hydraulic system pressure is supplied by the main hydraulic pump mounted on the transmission. The boom and bucket cylinders are operated by hydraulic fluid under pump pressure in response to the movement of the boom and bucket and accessory control levers that, in turn, position spools in the main control valve.

j. *Bucket.* The 4-in-1 bucket incorporates a

two-segment bucket which is opened and closed in a clam-shell manner by hydraulic cylinders to greatly increase the versatility of the loader.

#### 4. Identification

The loader has the following identification plates:

a. The loader serial number plate is mounted in the right front of the operator's compartment.

b. The engine identification plate is mounted on the side of the engine that is visible when viewing the right side of the loader engine compartment.

c. The fuel pump identification plate is on the side of the fuel pump that is visible when viewing the right side of the loader engine compartment.

d. The air compressor serial number plate is on the side of the air compressor that is visible when viewing the right side of the loader engine compartment.

#### 5. Tabulated Data

##### a. General.

Manufacturer ..... The Frank G. Hough Co.  
Model ..... H-90CM  
Type ..... Scoop  
Overall length ..... 264 $\frac{1}{2}$  in. (inches)  
Overall width, at bucket ..... 101 $\frac{1}{4}$  in.  
Overall height, bucket down ..... 102 in.  
Overall height, bucket fully raised ..... 189 in.  
Weight (approximate shipping). 24,500 lb (pounds)  
Dumping clearance maximum) when bottom dumped) 136 in.  
Maximum carrying capacity 8,000 lb  
SAE (Society of Automotive Engineers) struck capacity. 2 cu yd (cubic yards)  
SAE rated (normal heap) 2 $\frac{1}{2}$  cu yd

##### b. Engine.

Type ..... Diesel  
Make ..... Cummins  
Model ..... JT-6-B1  
Maximum hp (horsepower) 162 hp at 2200 rpm  
(revolutions per minute)  
Governed speed ..... 2200 rpm  
Bore ..... 4 $\frac{1}{8}$  in.  
Stroke ..... 5 in.  
Compression ratio ..... 16.3 to 1  
Engine breathing ..... Turbocharged  
No. (number) of cylinders 6  
Displacement ..... 401 cu in. (cubic inches)

##### c. Engine Accessories.

Generator:  
Make ..... Delco-Remy  
Part No. .... 1117478  
Rating ..... 24v (volts)  
Cranking motor:  
Make ..... Leece-Neville  
Part No. .... M0017060MP  
Rating ..... 24v  
Voltage Regulator:  
Make ..... Delco-Remy  
Part No. .... 1118558  
Air Compressor:  
Make ..... Cummins  
Model ..... BM-78986  
Capacity at rated speed 12 cfm (cubic feet per minute)  
Fuel Pump:  
Make ..... Cummins  
Model ..... BM-76775  
Air Cleaner:  
Make ..... Donaldson  
Part No. .... SBG12-0250  
Type ..... Dry

##### d. Torque Converter and Transmission.

Make ..... Rockwell-Standard  
Model ..... BDB-213-C-2  
Type ..... Power shift with torque converter  
Speeds ..... 4 forward and reverse  
Output Shafts ..... 2, 2- or 4-wheel drive  
Torque converter size ..... 15 in.

##### e. Bucket.

Make ..... Drott  
Model ..... 4-IN-1  
Part No. .... 32795  
Type ..... Clamshell

##### f. Steering Gear.

Make ..... Saginaw  
Model ..... 5692575  
Type ..... Mechanical with integral hydraulic valve

##### g. Main Hydraulic Pump.

Make ..... Denison  
Model ..... TDCO35-008-XL-10  
Rotation (viewed from Counterclockwise drive end).  
Main section rating, SAE 35 gpm (gallons per minute) at 1200 rpm and 100 psi (pounds per square inch)  
Steering section capacity, 8 gpm at 1200 rpm and SAE rating. 100 psi

##### h. Hydraulic Control Valve.

Make ..... Husco  
Model ..... 3703-17

##### i. Boom Cylinders.

Make ..... The Frank G. Hough Co.  
Part No. .... 192930  
Type ..... Double acting  
Diameter ..... 4 $\frac{1}{2}$  in.

*j. Bucket Cylinders.*

Make ----- The Frank G. Hough Co.  
Part No. ----- 192011  
Type ----- Double acting  
Diameter ----- 5 in.

*k. Brakes.*

Service ----- Air-over-hydraulic actu-  
ated, internal expanding  
shoe  
Parking ----- Mechanical, internal ex-  
panding shoe

*l. Tires.*

Size ----- 16:00 by 24  
Ply rating ----- 12 ply  
Type ----- Pneumatic  
Pressure ----- 45 psi.

*m. Electrical System.*

Voltage ----- 24  
Batteries (4):  
Voltage ----- 12  
Type ----- Lead acid  
Headlights ----- 1 blackout, 1 regular  
Floodlights ----- 5  
Tail and stoplight ----- 1 blackout, 2 regular  
Circuit breaker ----- 3  
Rating ----- 15 amp (amperes)

*n. Axles.*

Make ----- Rockwell-Standard  
Model:  
Front (rigid) ----- PR-204-H-X10  
Rear (steering) ----- PR-250-H-X23  
Reduction ratios:  
Differential ----- 5.29  
Planetary hubs ----- 3.6  
Total ----- 19.04

*o. Capacities.*

Engine crankcase:  
Initial fill ----- 19 qt (quarts)  
Refill ----- 19 qt  
Torque converter and trans-  
mission:  
Initial fill ----- 21 qt  
Refill ----- 21 qt  
Front drive axle:  
Differential ----- 22½ qt  
Planetary (each) ----- 2½ qt  
Rear drive axle:  
Differential ----- 20½ qt  
Planetary (each) ----- 2½ qt  
Main hydraulic system ----- 58 qt  
Fuel tank ----- 55 gal (gallons)  
Cooling system ----- 32 qt  
Steering gear ----- ¼ qt

*p. Pressures.*

Main hydraulic system ----- 2,000 psi max (maximum)  
Converter and transmission  
system:  
Clutch ----- 225 to 240 psi  
Lube oil ----- 25 to 40 psi  
Steering hydraulic system ----- 1,500 psi max  
1,000 psi min (minimum)  
Brake system (air) ----- 85 to 105 lb

*q. Engine Torque Valves.*

Crankshaft main bearing 30-35 ft-lb (foot pounds)  
screws (20, fig. 111). and advance 60 degrees  
Vibration damper screws 35-45 ft-lb  
(3, fig. 117).  
Connecting rod nuts (6, fig. 30 ft-lb and advance 60  
128). degrees  
Vibration damper hub re- 120-140 ft-lb  
tainer screws (13, fig. 118).  
Flywheel mounting screws 100-110 ft-lb  
(14, fig. 114).  
Cylinder head screws (27 400 ft-lb  
and 28, fig. 111).  
Injector mounting screws 10-12 ft-lb  
(9, fig. 150).  
Fuel inlet and drain con- 20-25 ft-lb  
nections (1 and 2, fig. 40)  
Crosshead adjusting screw 25-30 ft-lb  
nuts (8 and 17, fig. 129)  
Exhaust manifold screws 22 ft-lb  
(1, fig. 73).  
Turbocharger mounting 25 ft-lb  
nuts (22, fig. 70).  
Injector cup (8, fig. 150) 60 ft-lb  
Flywheel housing to bracket 80 ft-lb  
screws (9, fig. 110).  
Flywheel housing bracket 700 ft-lb  
to frame nuts (11, fig. 110).  
Fan end trunnion to frame 165 ft-lb  
nuts (6, fig. 110).

*r. Fuel Pump Torque Valves.*

Housing screws (44 and 9 ft-lb  
45, fig. 160).  
Fuel pump filter cap (11, 20-25 ft-lb  
fig. 160).

*s. Transmission Torque Valves.*

Transmission to mounting 160 ft-lb  
bracket.  
Transmission mounting 90 ft-lb  
bracket to frame  
Rear pump drive housing 20-25 ft-lb  
screws (12, fig. 187).  
Front pump drive housing 64-71 ft-lb  
screws (3, fig. 187).  
Input yoke retainer screws 35-40 ft-lb  
(90, fig. 188).  
Converter housing cover 22-24 ft-lb  
capscrews (86, fig. 188).  
Input shaft assembly cap- 38-42 ft-lb  
screws (80, fig. 188).  
Converter pump cover nuts 22-24 ft-lb  
(78, fig. 188).  
Accessory drive gear cap- 20-25 ft-lb  
screws (71, fig. 188).  
Ground sleeve screws (6, 26-29 ft-lb  
fig. 188).  
Transmission housing rear 26-29 ft-lb  
cover screws (48, fig. 188).



Dump valve assembly 15-17 ft-lb screws (18, fig. 188).  
 Transmission control valve 15-17 ft-lb screws (23, fig. 188).  
 Reverse idler shaft cap- 310-330 ft-lb screws (99, fig. 188).

#### *t. Turbosupercharger Torque Valves.*

Nozzle ring screw (7, fig. 100 in.-lb (inch-pounds) 219).  
 Nozzle ring nut (3, fig. 100 in.-lb 219).  
 Main casing screw (19, fig. 144 in.-lb 219).  
 Exhaust casing screw (14, 144 in.-lb fig. 219).  
 Front plate screw (37, fig. 84 in.-lb 219).  
 Thrust bearing screw (25, 100 in.-lb fig. 219).  
 Diffuser plate screw (30, 100 in.-lb fig. 219).

#### *u. Differential and Axle Torque Valves.*

Brake drum mounting nuts 168-180 ft-lb (18, fig. 211 and 46, fig. 212).  
 Steering trunnion lower 515-570 ft-lb capscrews (55 and 56, fig. 211).  
 Steering axle upper cap- 515-570 ft-lb screws (45 and 46, fig. 211).  
 Internal gear mounting 34-37 ft-lb screws (11, fig. 211 and 212).  
 Spindle mounting screws 186-205 ft-lb (38, fig. 212).  
 Planetary spider screws 85-91 ft lb (29, fig. 211 and 25, fig. 212).  
 Wheel hub mounting nuts 300-320 ft-lb (35, fig. 212 and 18, fig. 211).  
 Planetary cover mounting 85-91 ft-lb screws (29, fig. 211 and 25, fig. 212).  
 Differential mounting nuts -- 168-180 ft-lb  
 Steering axle mounting 460 ft-lb nuts (15, fig. 217).  
 Rigid axle mounting nuts 700 ft-lb (20, fig. 217).  
 Yoke and slinger to pinion 700-900 ft-lb mounting nuts (24, fig. 213).  
 Differential case mounting 90 ft-lb bolts (36, fig. 213).  
 Differential carrier screws 345-370 ft-lb (40, fig. 213).

Pinion bearing cage to car- 80-91 ft-lb rier screws (26, fig. 213).

#### *v. Miscellaneous Torque Valves.*

Hydraulic pump port plate 12-15 ft-lb screws (19, fig. 276).  
 Hydraulic pump housing to 130 ft-lb mounting cap capscrews (3, fig. 176).  
 Hydraulic pump end cap to 70-80 ft-lb housing capscrews (1, fig. 176).  
 Cylinder head screws (27 400 ft-lb and 28, fig. 111).  
 Steering gear housing side 25-30 ft-lb cover bolts (3, fig. 209).  
 Valve to housing adapter 17-23 ft-lb bolts (18, fig. 209).  
 Worm gear bearing nuts 20-30 ft-lb (before backing off) (23, fig. 209).  
 Valve cover bolts (44, fig. 17-23 ft-lb 209).  
 Main hydraulic pump 160 ft-lb mounting bolts (3, fig. 93).  
 Air compressor counter- 40 ft-lb weight screws (26, fig. 183).  
 Air compressor cylinder 35 ft-lb head screws (4 and 7, fig. 183).  
 Bucket cylinder end cap 35 ft-lb capscrews (6, fig. 180).  
 Boom cylinder rod end nuts 35 ft-lb (1, fig. 179).  
 Bucket tooth mounting nuts 390-440 ft-lb

#### *w. Wiring Diagram.*

Loader electrical system wiring diagram. Figure 4

#### *x. Shipping Dimensions.*

Loader shipping dimensions Figure 5

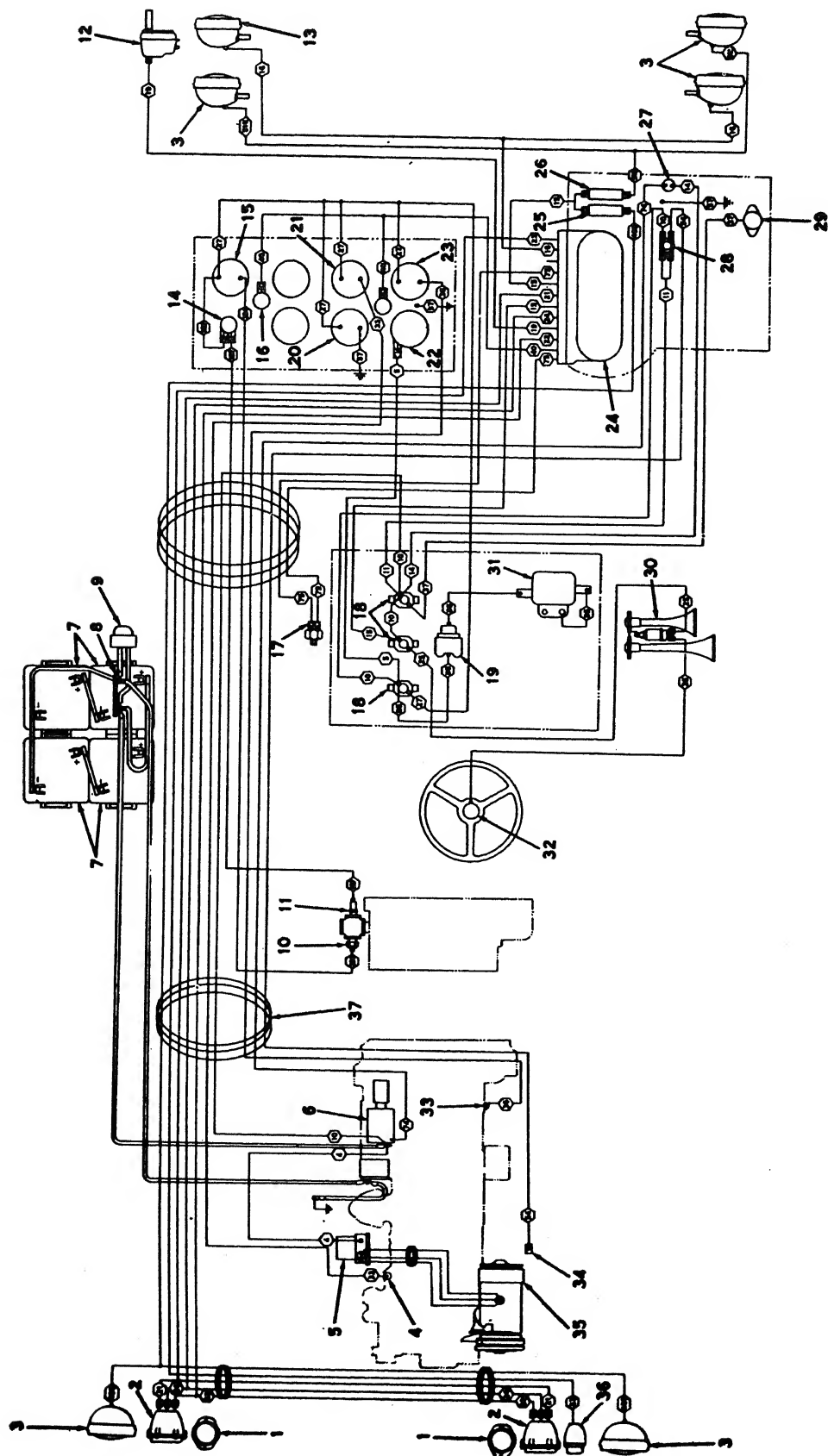
#### *y. Performance Data.*

Drawbar pull (dry concrete). 75 hp

#### Maximum speeds:

Range	Forward-mph (miles per hour)	Reverse (mph)
1	3.46	3.57
2	6.50	6.77
3	14.35	14.85
4	28.10	28.75

Lifting capacity to toe-----15,000 lb  
 Turning radius (outside rear corner grille). 25 ft  
 Ground clearance -----18 in.

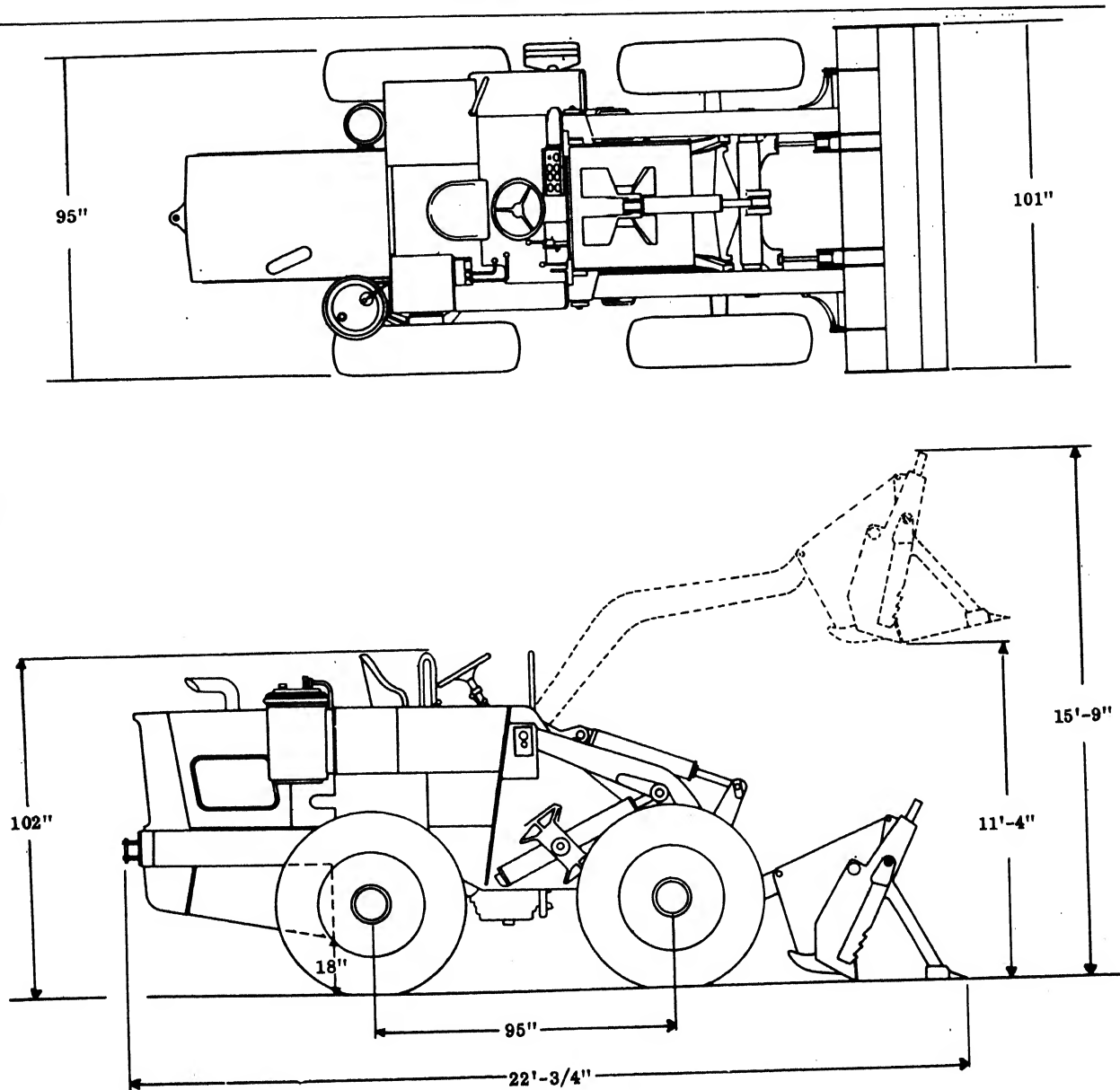


MSC 3805-201-15/4

Figure 4. Loader electrical system wiring diagram.

- |                             |  |                             |                               |
|-----------------------------|--|-----------------------------|-------------------------------|
| 1 Reflector                 | 12 Blackout headlight                        | 20 Hourmeter                | 29 Electrical outlet          |
| 2 Tail and stoplight        | 13 Headlight                                 | 21 Engine temperature gage  | 30 Air horn                   |
| 3 Floodlight                | 14 Torque converter temperature warning lamp | 22 Ammeter                  | 31 Low air pressure buzzer    |
| 4 Engine temperature sender | 15 Torque converter temperature gage         | 23 Engine oil pressure gage | 32 Horn button                |
| 5 Voltage regulator         | 16 Panel lamp                                | 24 Light control switch     | 33 Engine oil pressure sender |
| 6 Starting motor            | 17 Stoplight switch                          | 25 Rear floodlight switch   | 34 Fuel pump shutoff solenoid |
| 7 Batteries                 | 18 Circuit breakers                          | 26 Front floodlight switch  | 35 Generator                  |
| 8 Terminal block            | 19 Low air pressure indicator                | 27 Starter pushbutton       | 36 Blackout stoplight         |
| 9 External connector        |  | 28 Ignition switch          | 37 Wiring harness             |
| 10 Torque converter sender  |  |                             |                               |
| 11 Torque converter switch  |  |                             |                               |

Figure 4—Continued.



MSC 3805-201-15/5

Figure 5. Loader shipping dimensions.

## CHAPTER 2

### OPERATING INSTRUCTIONS

#### Section I. SERVICE UPON RECEIPT OF EQUIPMENT

##### 6. Unloading the Equipment

a. *Unloading by Hoist.* Refer to figure 6 and remove all blocking and tiedowns that secure the loader to the carrier. Use a crane that is capable of handling 24,500 pounds. Connect the hooks of the sling to the lifting points (fig. 6) provided. Use sling spreader bars to prevent damage to the sheet metal parts of the loader. Refer to figure 6.

**Caution:** Do not allow the loader to swing back and forth when it is suspended in the air. Use extreme care when working close to a cable or chain under tension.

b. *Unloading by Ramp.*

- (1) If a suitable unloading ramp is not available, refer to figure 7 and construct an unloading ramp at the end of the railway flatcar. Use 6- by 6-inch timber to construct the ramp runners (1) and vertical supports (2). Secure the runners and vertical supports with 2- by 4-inch timber crossmembers (3). When construction has been completed on both sides, nail 2- by 12-inch timbers on the top runners for the ramp surface, then block the flatcar wheels with 6- by 6-inch timber on each side.
- (2) If the loader is towed from the flatcar, use a suitable snubbing device.
- (3) If the loader is driven from the flatcar, refer to paragraphs 7 through 9 for servicing procedures.

##### 7. Unpacking Equipment

a. *Unpacking.* If batteries and electrolyte are boxed, exercise care in opening boxes.

b. *Depreservation.* Prepare the loader for inspection and operation as outlined on DA Form 2258 attached to or near the operational controls.

##### 8. Inspection of Equipment (fig. 8)

Inspect the entire loader for loss or damage that may have occurred in shipment. Make a systematic check including the following items:

a. *Engine.*

- (1) *Fuel system.* Check all connections and lines in the fuel system to see that they are secure and not damaged. Make sure that the fuel pump, injectors, and filters are securely mounted.
- (2) *Cooling system.* Check that the water pump, thermostat housing, and radiator are securely mounted. Check that the hoses are properly connected and that all hose clamps are properly in place and secure.
- (3) *Lubrication system.* Check all drain plugs for proper installation. Check the engine oil filter and all lubrication lines for proper mounting.
- (4) *Intake and exhaust systems.* Check that the air cleaner, crankcase breather, intake manifold, exhaust manifold, and exhaust pipe are securely mounted.
- (5) *Engine electrical system.* Check the starting motor, generator, voltage regulator, and batteries for secure mounting and for clean, tight electrical connections. Check the batteries for cracks or damage.

b. *Hydraulic System.* Check the boom, bucket, and steering cylinders for secure mounting and tight hydraulic connections. Check the hydraulic reservoir and filters for leaks or damage.

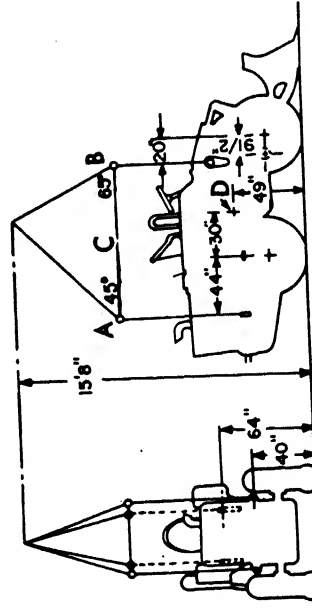
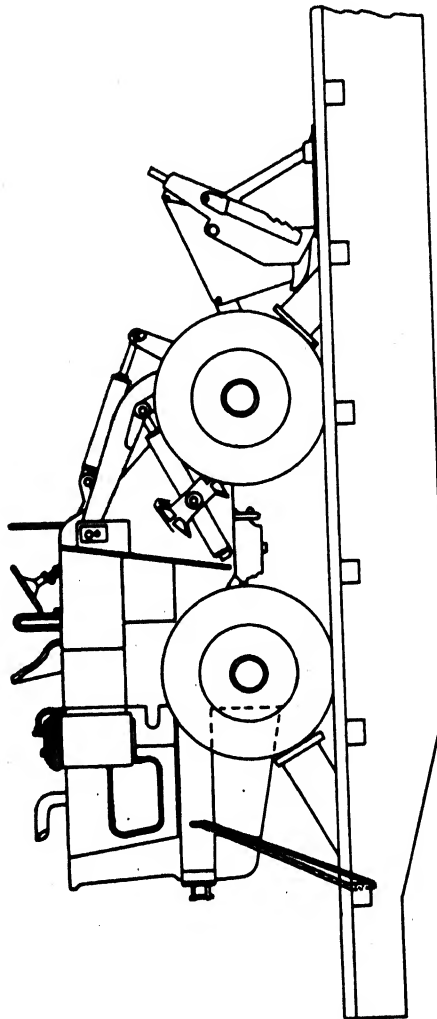
c. *Vehicular Electrical System.* Check the vehicle for secure electrical connections. Check the headlights, floodlights, blackout lights, and rear lights for cracked bulbs, loose mounting, or damage.

d. *Instrument Panel.* Check the instrument panel for loosely mounted instruments, cracked dial faces, and loose connections.

e. *Controls.* Check the operation of all controls for binding or disconnected linkage.

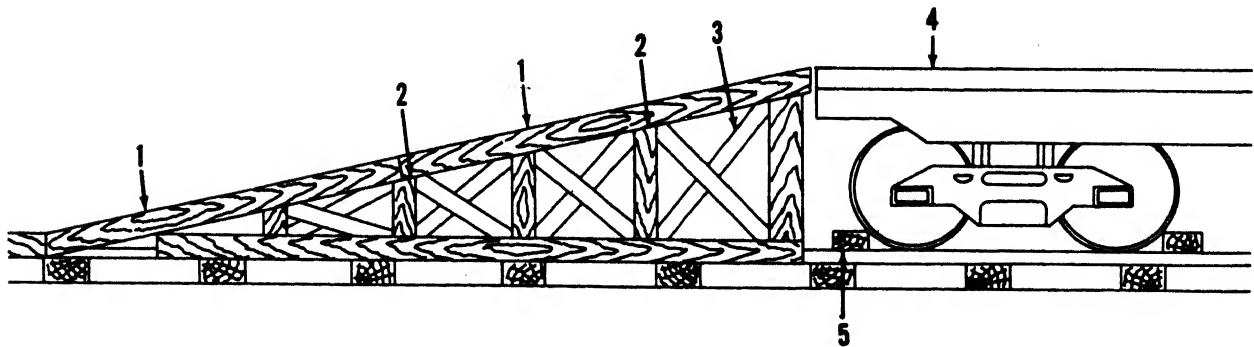
f. *Axles and Mounting.* Check the axles for missing hardware and insecure mounting.

g. *Tires.* Check the tires for cuts, punctures, loss of air, missing valve caps, or other damage.



MSC 3805-201-15/6

Figure 6. Loader tiedown and hoisting diagrams.



1 Ramp runners

2 Ramp vertical supports

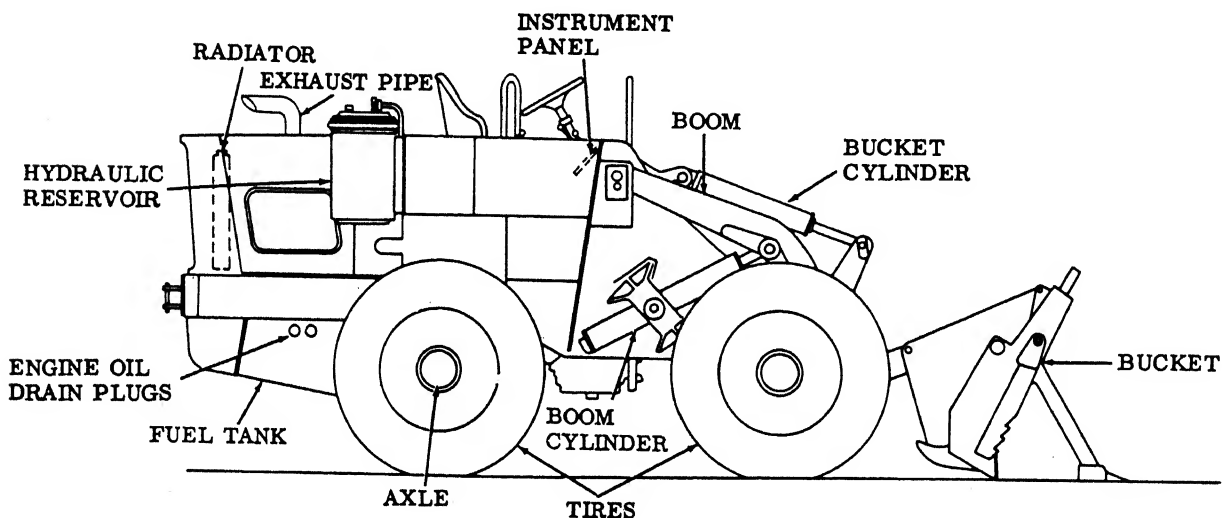
3 Ramp crossmembers

4 Flatcar

MSC 3805-201-15/7

5 Flatcar wheel blocks

Figure 7. Unloading ramp.



MSC 3805-201-15/8

Figure 8. Areas requiring inspection.

*h. Boom and Bucket.* Check the boom and bucket for distortion and missing parts.

## 9. Servicing Equipment (fig. 9)

*a.* Fill the fuel tank with diesel fuel of the correct specification. Check fuel lines and connections for leaks.

*b.* Drain the preservative oil from the engine. Fill with new engine oil and lubricate the entire machine as described in the lubrication order (fig. 27).

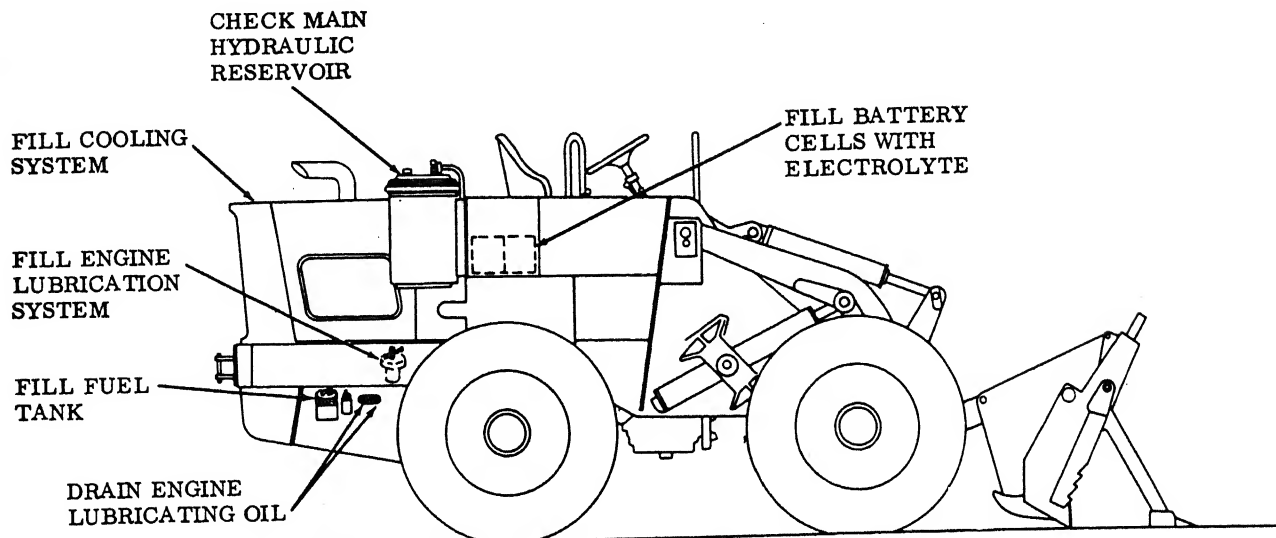
*c.* Service the cooling system by adding 32

quarts of coolant to the system. In sub-freezing temperatures, make sure that sufficient ethylene glycol is added to the system to protect it from freezing in the coldest temperature to be encountered.

*d.* Check the level of the hydraulic reservoir; if necessary, fill with hydraulic fluid as indicated in the lubrication order.

*e.* Perform all of the before-operation services listed in paragraph 57.

*f.* Fill the battery cells with the electrolyte shipped with the equipment; fill to bottom of the filler hole.



MSC 3805-201-15/9

Figure 9. Areas requiring servicing.

## Section II. CONTROLS AND INSTRUMENTS

### 10. General

Before operating the loader, it is essential that the operator become familiar with the location and function of all controls and instruments. This section describes, locates, and informs the operator about the various controls and instruments to ensure proper operation of the loader. The operator should work slowly and carefully until he has become thoroughly accustomed to the machine. The terms "right" and "left" referred to in the text are determined by sitting in the operator's seat and facing the front of the loader.

### 11. Steering Wheel

(fig. 10)

*a. Location.* The steering wheel (24) is located on the top of the steering column in front of the operator's seat.

*b. Purpose.* The steering wheel controls the movement of the loader to the left or to the right by varying the direction of the rear wheels.

### 12. Horn Button

(fig. 10)

*a. Location.* The horn button (29) is mounted in the center of the steering wheel.

*b. Purpose.* When depressed, it causes the horn to sound.

### 13. Range Shift Lever

(fig. 10)

*a. Location.* The range shift lever (33) is mounted on the left side of the steering column.

*b. Purpose.* The range shift lever is connected to the transmission to control the output ratio of the transmission. It has four positions. In the position nearest the operator, it provides the highest speed range of the loader. In the position farthest from the operator, it provides the lowest speed range. Two intermediate settings are between the two extremes.

### 14. Directional Shift Lever

(fig. 10)

*a. Location.* The directional shift lever (2) is mounted on the left side of the steering column.

*b. Purpose.* The directional shift lever is connected to the transmission to control the direction of movement of the loader. When it is moved away from the operator, it causes forward movement of the loader. When it is moved toward the operator, it causes reverse movement of the loader. The mid-position is the neutral position, in which no power is supplied through the transmission.

### 15. Engine Temperature Gage

(fig. 10)

*a. Location.* The engine temperature gage

(7) is located on the upper right center of the instrument panel.

*b. Purpose.* The engine temperature gage indicates the engine coolant temperature.

*c. Readings.* The normal engine coolant temperature of an engine that has been running is between 165° F. and 185° F. If the engine coolant temperature approaches 220° F., it indicates dangerous engine temperatures. Shut off the engine (par. 44) and allow it to cool before continuing operation.

#### **16. Ammeter** (fig. 10)

*a. Location.* The ammeter (9) is located on the lower right of the instrument panel.

*b. Purpose.* The ammeter indicates the rate of charge or discharge of the batteries.

*c. Readings.* The indication range of the ammeter is from -40 amperes (discharge) to +40 amperes (charge). The normal reading of the ammeter when the batteries are charged and the engine is running should be zero or a few amperes to the charge side of the zero mark. Immediately after starting, the ammeter should indicate a higher charging rate, but should taper off toward the normal indication after engine runs long enough to recharge the battery. Battery discharge while engine is running indicates an overloaded electrical system or improperly functioning electrical components.

#### **17. Engine Oil Pressure Gage** (fig. 10)

*a. Location.* The engine oil pressure gage (8) is mounted on the upper right of the instrument panel.

*b. Purpose.* The oil pressure gage indicates engine oil pressure.

*c. Readings.* The oil pressure gage has a range indication from 0 to 80 psi. At working speed ranges, the gage should indicate between 30 and 75 psi. At idle speed, the gage should indicate 5 to 15 psi. Gage indications of less than 30 psi at governed speed indicate a dangerous condition; shut off the engine and check the oil supply.

#### **18. Transmission Clutch Oil Pressure Gage** (fig. 10)

*a. Location.* The transmission clutch oil

pressure gage (5) is located on the upper left center of the instrument panel.

*b. Purpose.* The transmission clutch oil pressure gage indicates the transmission oil pressure.

*c. Readings.* Transmission clutch oil pressure should be at a minimum of 160 psi during normal operation. Do not operate the loader if the pressure gage indicates less than 160 psi.

#### **19. Torque Converter Oil Temperature Gage** (fig. 10)

*a. Location.* The torque converter oil temperature gage (3) is located on the upper left of the instrument panel.

*b. Purpose.* The torque converter oil temperature gage indicates the temperature of the oil leaving the torque converter.

*c. Readings.* The torque converter oil temperature gage should read less than 250° F. during normal operation. In a higher reading than this is noted while operating under a heavy load, downshift to the next range to decrease the torque converter load and reduce the temperature.

#### **20. Torque Converter Temperature Warning Lamp** (fig. 10)

*a. Location.* The torque converter temperature warning lamp (34) is mounted on the lower left of the instrument panel.

*b. Purpose.* The torque converter temperature warning lamp lights to alert the operator of a dangerously high torque converter oil temperature. The lamp lights when the temperature reaches 250° F.

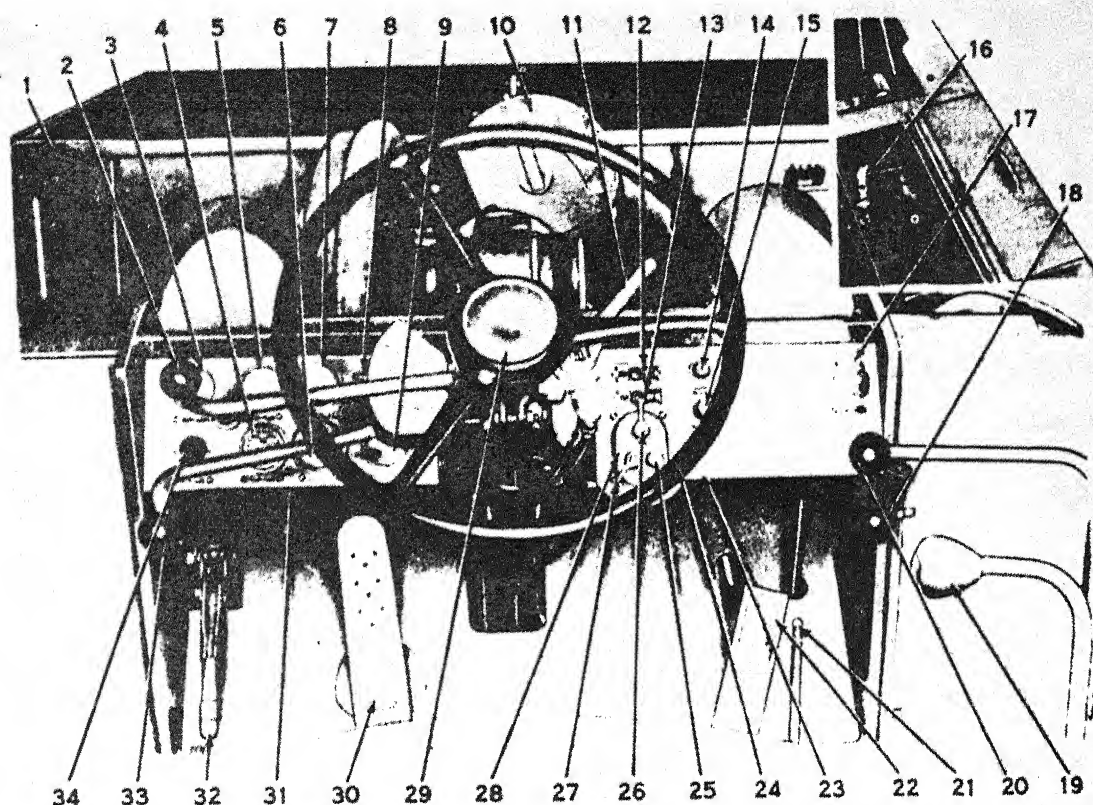
#### **21. Air Pressure Gage** (fig. 10)

*a. Location.* The air pressure gage (4) is mounted on the lower left center of the instrument panel.

*b. Purpose.* The air pressure gage indicates the reservoir pressure of the air to operate the air-over-hydraulic brake system and the horn.

*c. Readings.* The gage has a range of 0 to 300 psi, with calibrations at 75 and 125. During normal operation, the gage should indicate in the green area between 85 and 105 psi. Do not operate the loader unless the gage indication is within this range.





MSC 3805-201-15/10

- |   |                              |                                       |  |
|---|------------------------------|---------------------------------------|--|
| 1 Bucket opening indicator              | 9 Ammeter                    | 18 Axle disengage lever               | 27 Panel and park lamp selector switch       |
| 2 Directional shift lever               | 10 Bucket position indicator | 19 Bucket and accessory control lever | 28 Light control switch                      |
| 3 Torque converter oil temperature gage | 11 Hand brake valve          | 20 Boom control lever                 | 29 Horn button                               |
| 4 Air pressure gage                     | 12 Front floodlight switch   | 21 Hand throttle lever                | 30 Brake pedal                               |
| 5 Transmission clutch oil pressure gage | 13 Rear floodlight switch    | 22 Foot throttle                      | 31 Instrument panel                          |
| 6 Hourmeter                             | 14 Starter pushbutton        | 23 Light and ignition control panel   | 32 Parking brake lever                       |
| 7 Engine temperature gage               | 15 Ignition switch           | 24 Steering wheel                     | 33 Range shift lever                         |
| 8 Engine oil pressure gage              | 16 Primer discharger         | 25 Unlock lever                       | 34 Torque converter temperature warning lamp |
|   | 17 Electrical outlet         | 26 Drive lamp selector switch         |  |

Figure 10. Controls and instruments.

## 22. Hourmeter (fig. 10)

a. *Location.* The hourmeter (6) is mounted on the lower right of the instrument panel.

b. *Purpose.* The hourmeter indicates in hours and tenths of hours the length of time the engine has operated.

## 23. Ignition Switch (fig. 10)

a. *Location.* The ignition switch (15) is located on the light and ignition control panel

(23), to the right of the steering column.

b. *Purpose.* The ignition switch opens and closes the ignition circuits of the loader. In the OFF position, it prevents the solenoid switch from cranking the motor and prevents the fuel shutoff valve on the fuel pump from opening when the starter pushbutton is depressed. In the ON position, it permits these components to energize and start the engine. In the ON position, it closes the circuit to the low air pressure indicator to sound the buzzer if a low air pressure condition exists.

**24. Starter Pushbutton**  
(fig. 10)

*a. Location.* The starter pushbutton (14) is located above the ignition switch on the light and ignition control panel (23).

*b. Purpose.* When the ignition switch (15) is in the ON position and the starter pushbutton is depressed, the starter solenoid is energized and the engine is cranked by the starting motor to start the engine.

**25. Light Control Switch**  
(fig. 10)

*a. Location.* The light control switch (28) is located on the lower left of the light and ignition control panel (23).

*b. Purpose.* The light control switch controls the lighting of the vehicle to make it conform to the tactical situation under which the equipment is operating. It is equipped with a locking device to prevent the switch settings from being accidentally shifted by the operator. The light control switch incorporates the controls described in paragraphs 26 through 28.

**26. Drive Lamp Selector Switch**  
(fig. 10)

*a. Location.* The drive lamp selector switch (26) is located on the upper portion of the light control switch (28).

*b. Purpose.* The drive lamp selector switch controls the selection of the drive lamps of the loader. It can be moved only when the UNLOCK lever (25) is operated. It has the following positions:

- (1) *B.O. DRIVE.* This position closes the circuit to light the blackout driving lights for night driving under blackout conditions.
- (2) *B.O. MARKER.* This position closes the circuit to light the blackout marker lights for night parking under blackout conditions.
- (3) *OFF.* This position prevents any of the associated lights from being lighted.
- (4) *STOPLIGHT.* This position permits the regular stop and taillight to operate in a normal manner with the stoplight under control of the stoplight switch in the brake system.
- (5) *SER. DRIVE.* This position shifts

control of the external lights to the front and rear floodlight switches (pars. 29 and 30).

**27. Panel and Park Lamp Selector Switch**  
(fig. 10)

*a. Location.* The panel and park lamp selector switch (27) is located on the lower left of the light control switch (28).

*b. Purpose.* The panel and park lamp selector switch controls the operation of the panel lamps and parking lamps. It can be moved only when the UNLOCK lever (25) is operated. It has the following positions:

- (1) *PANEL BRT.* This position closes the circuit to light the panel lamps to their normal brightness.
- (2) *DIM.* This position closes the circuit to light the blackout panel lamps.
- (3) *OFF.* This position prevents either the panel lamps or parking lamps from being lighted.
- (4) *PARK.* This position closes the circuit to light the parking lamps.

**28. Unlock Lever**  
(fig. 10)

*a. Location.* The UNLOCK lever (25) is located on the lower right of the light control switch (28).

*b. Purpose.* The UNLOCK lever, when moved upward, releases the drive lamp selector switch (26) and the panel and park lamp selector switch (27) to permit their positions to be changed. In the normal position, this lever prevents the two switches from being operated.

**29. Front Floodlight Switch**  
(fig. 10)

*a. Location.* The front floodlight switch (12) is located on the upper left of the light and ignition control panel (23).

*b. Purpose.* The front floodlight switch, when moved to the ON position, permits the front floodlights to be lighted when the drive lamp selector switch (26) on the light control switch (28) is in the SER. DRIVE position.

**30. Rear Floodlight Switch**  
(fig. 10)

*a. Location.* The rear floodlight switch (13) is located to the left of the light and ignition

control panel (23) between the front floodlight switch (12) and the light control switch (28).

*b. Purpose.* The rear floodlight switch permits the rear floodlights to be lighted when the drive lamp selector switch (26) on the light control switch (28) is in the SER. DRIVE position.

### 31. Handbrake Valve (fig. 10)

*a. Location.* The handbrake valve (11) is mounted on the right side of the steering column.

*b. Purpose.* The handbrake valve controls the air flow to the trailer couplings at the rear of the loader to operate the brake system of a vehicle being towed. Moving the valve lever to the rear causes brake application; moving the lever forward releases the brake.

### 32. Bucket Position Indicator (fig. 10)

*a. Location.* The bucket position indicator (10) is mounted on the bucket cylinder directly ahead of the steering wheel.

*b. Purpose.* The bucket position indicator informs the operator of the operating position of the bucket as shown in figure 11. It has the following positions: BULLDOZER, SCRAPER, BUCKET, and CLAMSHELL.

### 33. Bucket and Accessory Control Lever

*a. Location.* The bucket and accessory control lever (19, fig. 10) is located to the right of the operator's seat.

*b. Purpose.* The bucket and accessory control lever controls the dumping and the opening and closing of the bucket. It can be moved in four directions, forward, back, left, or right as shown in figure 12. Moving the lever forward causes the bucket to dump; moving the lever to the rear causes the bucket to tilt back. Moving the lever to the right causes the bucket to open; moving the lever to the left causes the bucket to close. The midposition of the lever holds the bucket in position.

### 34. Boom Control Lever

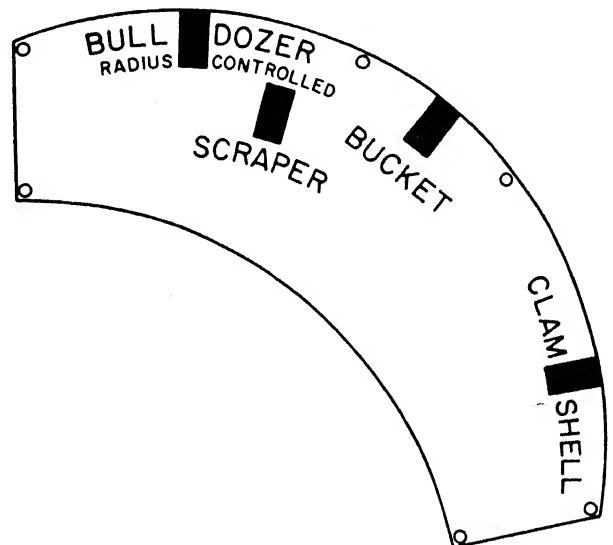
*a. Location.* The boom control lever (20, fig. 10) is the forward lever located to the right of the operator's seat.

*b. Purpose.* The boom control lever operates the main hydraulic control valve to control the

operation of the loader boom. It has four positions as shown in figure 13. These positions are as follows:

- (1) **RAISE.** In this position, the boom raises and will continue to raise until it reaches the limit of its upward travel or until the control is moved.
- (2) **HOLD.** In this position, the boom will remain in the selected position.
- (3) **LOWER.** In this position, the boom will lower under power until it reaches the lower limit of its travel or until the control is moved.
- (4) **FLOAT.** In this position, the boom is free to move in either direction. If the boom is raised when the lever is in the FLOAT position, the boom will lower by its own weight.

**Caution:** Do not operate the boom and bucket and accessory control



MSC 3005-201-15/11

Figure 11. Bucket position indicator positions for various bucket conditions.

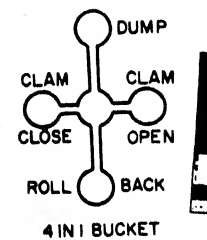


Figure 12. Bucket and accessory control lever positions.

levers when the engine is not running, as the boom can be lowered at any time by operating the boom control to the LOWER or FLOAT position.

### 35. Axle Disengage Lever (fig. 10)

*a. Location.* The axle disengage lever (18) is located at the far right of the light and ignition control panel.

*b. Purpose.* The axle disengage lever permits the selection of one-axle or two-axle drive. When the lever is moved to the forward position, both the front and rear axles are engaged and drive the unit. When the lever is moved toward the operator, the rear axle is disengaged and only the front axle drives the unit.

**Caution:** Operate the axle disengage lever only when the loader is not in motion. If the lever cannot be shifted when the loader is stopped, allow the loader to move at a creeping rate of speed until the shift can be made.

### 36. Parking Brake Lever (fig. 10)

*a. Location.* The parking brake lever (32) is located on the floorboard to the left front of the operator.

*b. Purpose.* The parking lever controls the application and release of the parking brake. When it is pushed forward it causes application of the brake. When it is moved to the rear, it releases the brake.

### 37. Brake Pedal (fig. 10)

*a. Location.* The brake pedal (30) is located on the floorboard to the left of the steering column.

*b. Purpose.* The brake pedal regulates the flow of air pressure to the air-over-hydraulic

brake system to slow or stop the vehicle. Light brake pedal application causes light braking. Heavy application causes strong braking. When applied, the brake pedal also directs air to a valve in the transmission control valve to disconnect power to the drive axles.

### 38. Foot Throttle (fig. 10)

*a. Location.* The foot throttle (22) is located on the floorboard to the right of the steering column.

*b. Purpose.* The foot throttle provides foot control of the engine speed, permitting rapid variation of the speed to meet operating conditions. Depressing the pedal increases engine speed. When it is not depressed, the engine operates at idle speed, unless the hand throttle control is operated.

### 39. Hand Throttle Lever (fig. 10)

*a. Location.* The hand throttle lever (21) is mounted on the floorboard to the right front of the operator's seat.

*b. Purpose.* The hand throttle lever is provided to manually adjust the engine speed to the desired setting without keeping a foot on the foot throttle. Moving the lever forward increases engine speed; moving the lever to the rear decreases engine speed.

### 40. Bucket Opening Indicator (fig. 10)

*a. Location.* The bucket opening indicator (1) is located on the bucket hinge on the left side of the bucket.

*b. Purpose.* The bucket opening indicator shows the operator how far the bucket is open. It has numbers 0, 2, and 4 on the indicator plate. The lower the number that is indicated by the pointer on the hinge, the less the bucket is open.

### 41. Hand Primer and Fuel Level Indicator

*a. Hand Primer Pump (B, fig. 14)*

(1) *Location.* The hand primer pump (1) is located on the frame at the right side of the engine below the compressor.

(2) *Purpose.* The hand primer pump is used to aid starting, especially after the equipment has been idle for a

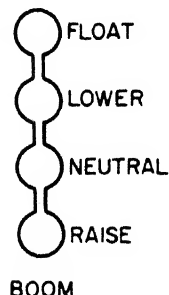
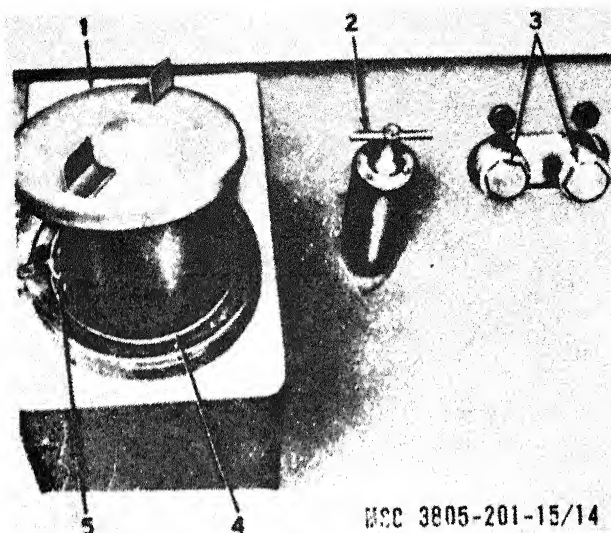


fig 3845-201 15 13

Figure 13. Boom control lever positions.

considerable length of time. When pumped, it primes the fuel pump only.

**Caution:** Use of the hand primer when the fuel pump is full may force raw fuel through an open injector into an engine cylinder and cause serious damage to the engine. Do not use the hand primer pump when there is fuel in the fuel pump.



- |                        |                         |
|------------------------|-------------------------|
| 1 Fuel filler cap      | 3 Engine oil drain plug |
| 2 Fuel level indicator | 4 Strainer screen       |
|                        | 5 Chain                 |

A—Fuel tank

Figure 14. Hand primer pump and fuel tank.

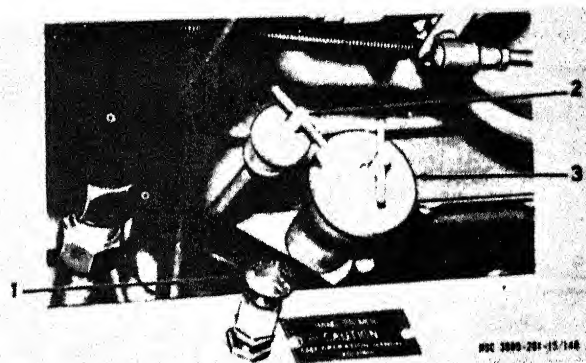
#### b. Fuel Level Indicator (A, fig. 14)

- (1) *Location.* The fuel level indicator (2) is located on the fuel tank to the right of the fuel filler cap (1).
- (2) *Purpose.* The fuel level indicator is used as a dipstick to check the level of fuel in the fuel tank.

### 42. Low Air Pressure Buzzer (fig. 10)

a. *Location.* The low air pressure buzzer is located under the instrument panel (31).

b. *Purpose.* The low air pressure buzzer sounds when the ignition is turned on and the air pressure in the air tank is less than 54 psi.



- |                         |                         |
|-------------------------|-------------------------|
| 1 Hand primer pump      | 3 Engine oil filler cap |
| 2 Engine oil level gage |                         |

B—Hand primer pump installation

Figure 14—Continued.

## Section III. OPERATING DETAILS

### 43. Starting

a. Make sure the parking brake lever (32, fig. 10) is in the applied position.

b. Check that the bucket is on the ground and that the boom control lever (20) and bucket and accessory control lever (19) are in the HOLD positions.

c. Start the engine as shown in figure 15.

### 44. Stopping

a. Stop the loader as shown in figure 15.

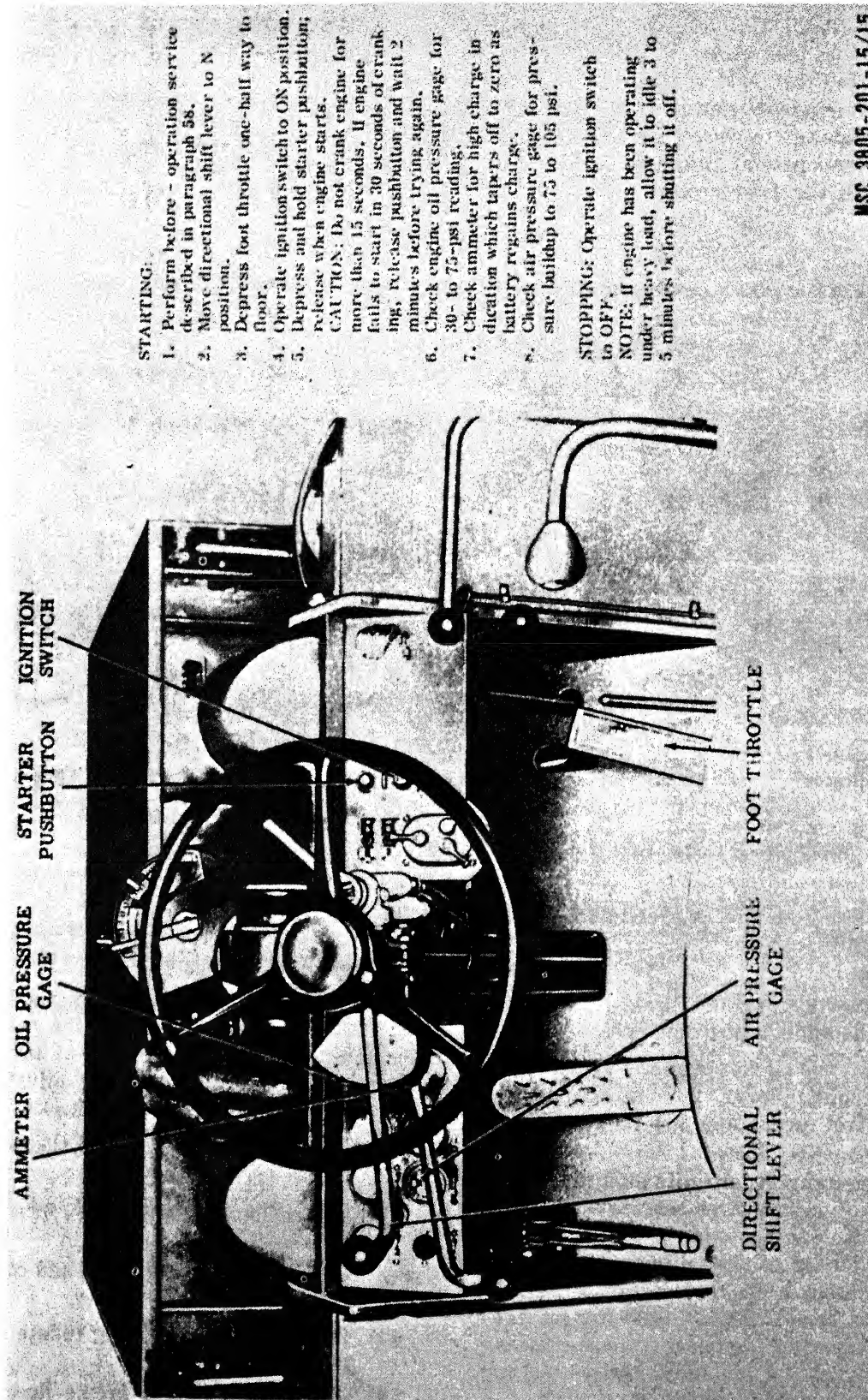
b. In temperatures above freezing, raise the parking brake lever (32, fig. 10) to set the brake. In subfreezing temperatures, do not apply the parking brake, but block the wheels to prevent the loader from rolling.

### 45. Operating Details

a. *Preliminary Steps Prior to Starting Operation.* Before starting operation of the loader at the beginning of the work shift, or at any time the machine has been shut down for adjustment or time off, perform the following checks:

- (1) Check the fuel supply; fill the tank if necessary.
- (2) Check the engine oil level; add oil if necessary.
- (3) Check the cooling system; add coolant and antifreeze if necessary.
- (4) Check the tire pressure; inflate to 45 psi.
- (5) Check the oil level in the hydraulic





# **STARTING:**

1. Perform before - operation service described in paragraph 58.
2. Move directional shift lever to N position.
3. Depress foot throttle one-half way to floor.
4. Operate ignition switch to ON position.
5. Depress and hold starter pushbutton.

## **CAUTION:**

- Do not crank engine for more than 15 seconds. If engine fails to start in 30 seconds of cranking, release pushbutton and wait 2 minutes before trying again.
6. Check engine oil pressure gage for 30- to 75-psi reading.
  7. Check ammeter for high charge indication which tapers off to zero as battery regains charge.
  8. Check air pressure gage for pressure buildup to 75 to 105 psi.

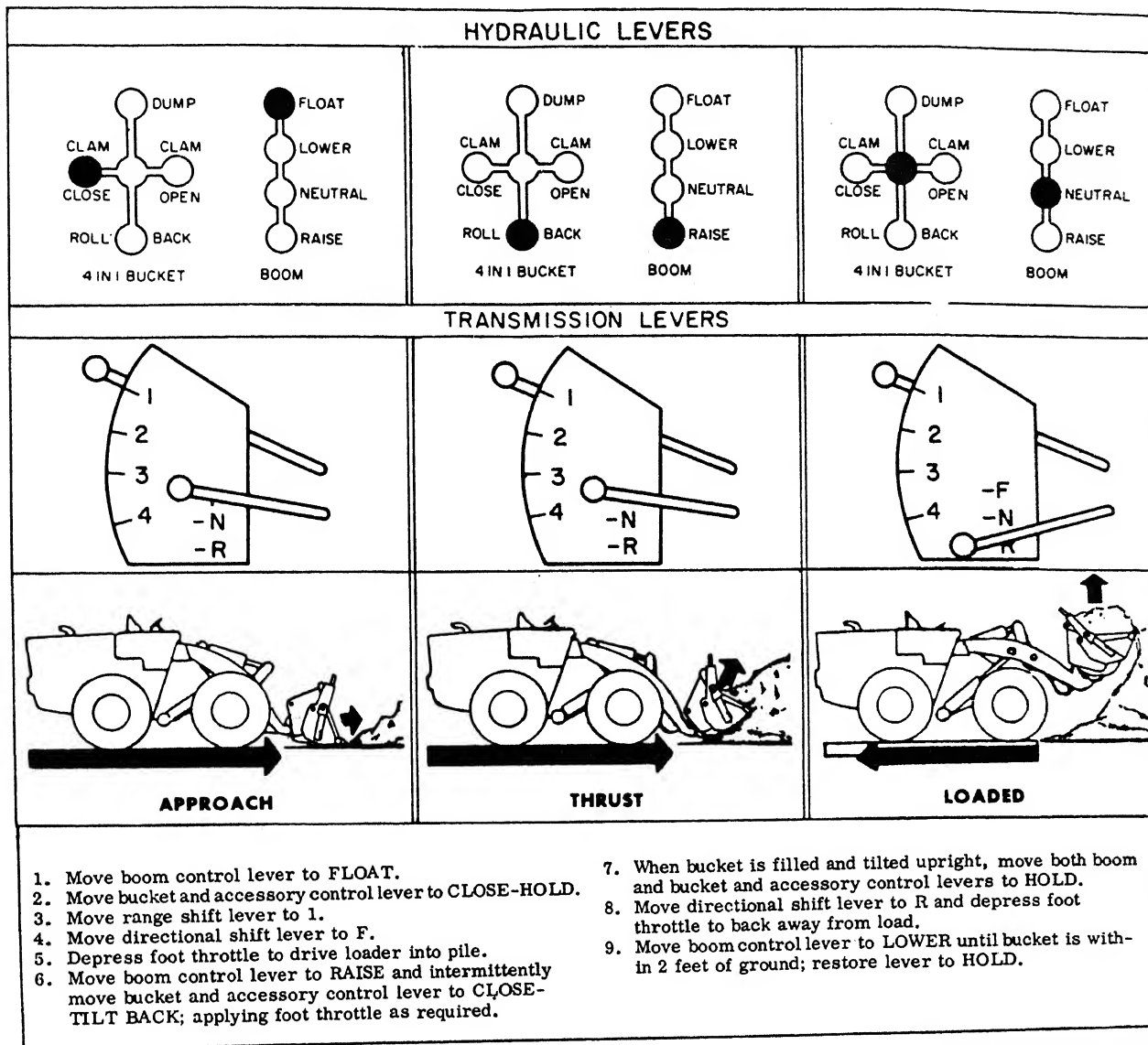
# **STOPPING:**

Operate ignition switch to OFF.

NOTE: If engine has been operating under heavy load, allow it to idle 3 to 5 minutes before shutting it off.

MSC 3005-201-15/15

Figure 15. Starting and stopping the engine.



MSC 3805-201-15/16

Figure 16. Loading the bucket, scoop method.

system reservoir; add hydraulic oil if necessary.

- (6) Service any other units at this time if inspection indicates service is needed.

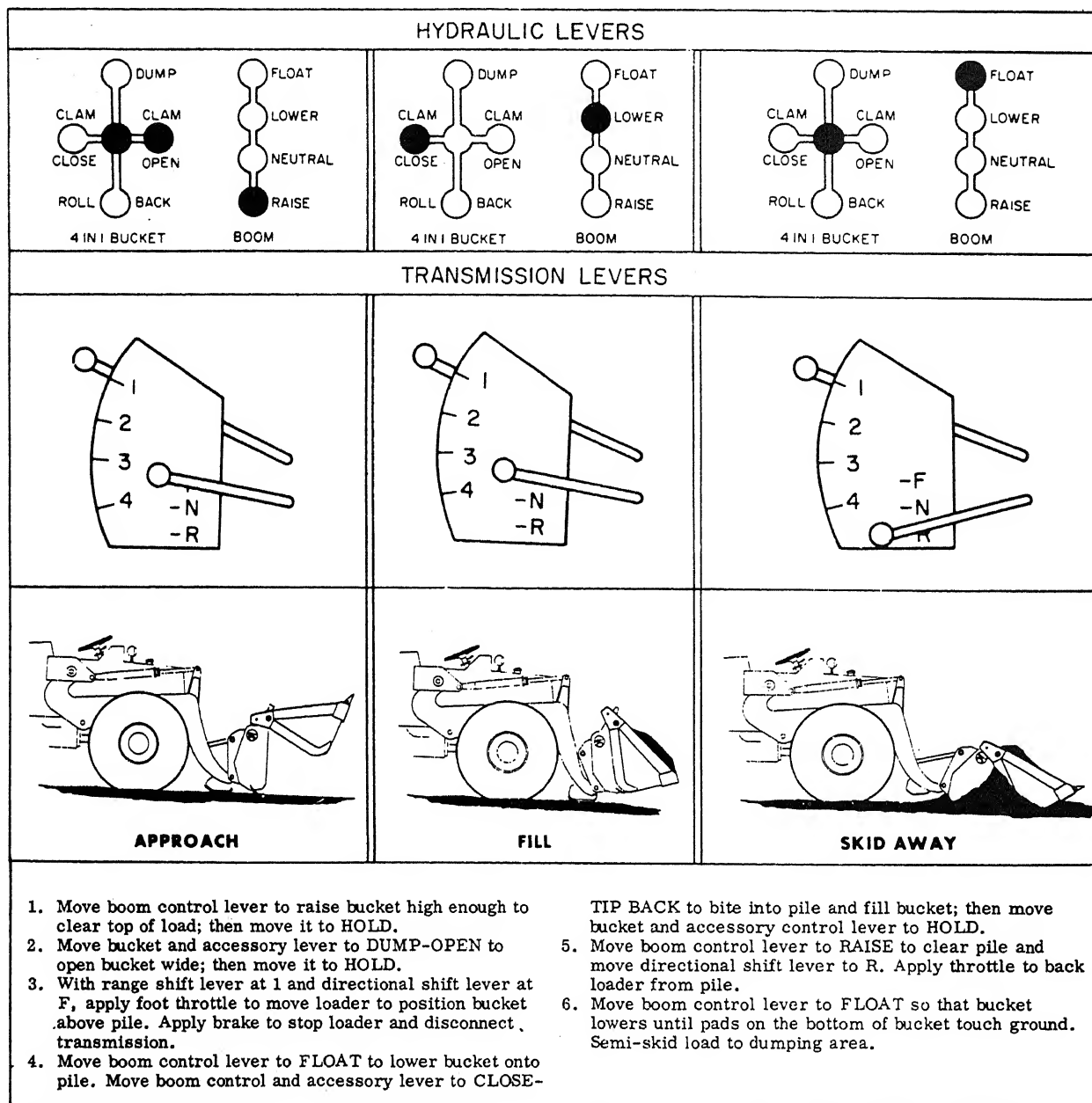
**b. Starting the Equipment.**

- (1) Start the engine as described in paragraph 43.
- (2) Allow the engine to warm up to operating temperature before applying a heavy load. Use only partial power until the engine temperature gage indicates 160° F.
- (3) Maintain a careful check of the in-

struments on the instrument panel (31, fig. 10) to make sure they indicate within the required range.

**c. Positioning of Controls.** Some of the controls require special conditions before they can be shifted or moved. These controls are as follows:

- (1) The parking brake lever (32) is used primarily to hold the loader after it has come to a stop. This brake should not be used as a service brake. In case of an emergency, if the service brakes



MSC 3805-201-15/17

Figure 17. Loading the bucket, clamshell method.

- fail, the parking brake may be used to help make an emergency stop.
- (2) The range shift lever (33) can be shifted while the engine is developing power but should be shifted before full engine speed is developed.
  - (3) The directional shift lever (2) can be shifted while the engine is developing power at low engine speeds and low

- travel speeds. Do not attempt to shift at high engine or travel speeds.
- (4) The axle disengage lever (18) should be operated only when the loader movement is stopped. If the lever cannot be shifted when the loader is stopped, move the loader at a creeping rate of speed until the shift can be made.



- (5) The boom control lever (20) and bucket and accessory control lever (19) should not be operated when the engine is stopped. However, if the boom is raised, the boom control lever can be moved to the LOWER or FLOAT position to lower the boom.

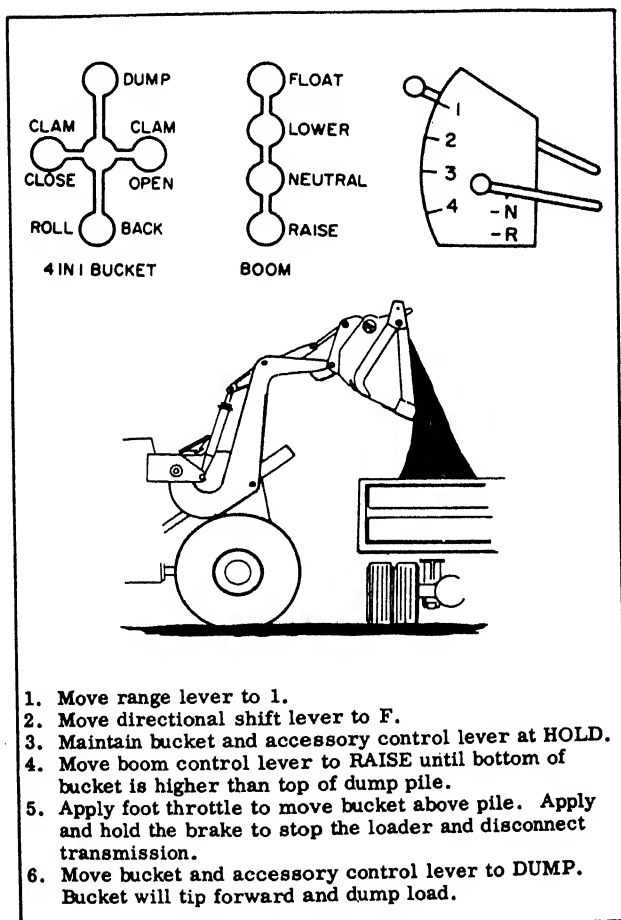
**Caution:** Do not operate the boom and bucket and accessory control levers when the engine is not running, as the boom can be lowered at any time by operating the boom control to the LOWER or FLOAT position.

- (6) The brake pedal (30), when applied, not only operates the service brakes, but disconnects the transmission to prevent power from being applied to the wheels. Depress and hold the brake pedal when speeding up the engine to

operate the hydraulic components of the unit.

**d. Performance Details.**

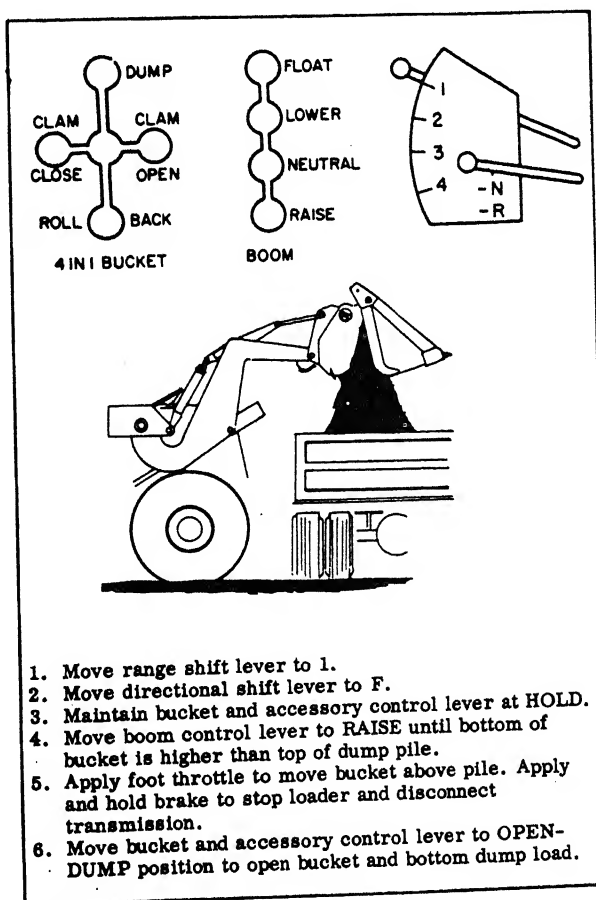
- (1) Loading the bucket, scoop method.
- (a) Load the bucket as shown in figure 16.
  - (b) Operate the bucket and accessory control lever intermittently because the bucket hydraulic circuit overrides the boom circuit. Operation of the bucket circuit cuts off the operation of the boom circuit.
  - (c) When digging into a hard surface, alternate the bucket and accessory control lever between the CLOSE and OPEN positions to wiggle the bucket edge immediately after penetration.
- (2) Loading the bucket, clamshell method. Load the bucket as shown in figure 17.



MSC 3805-201-15/18

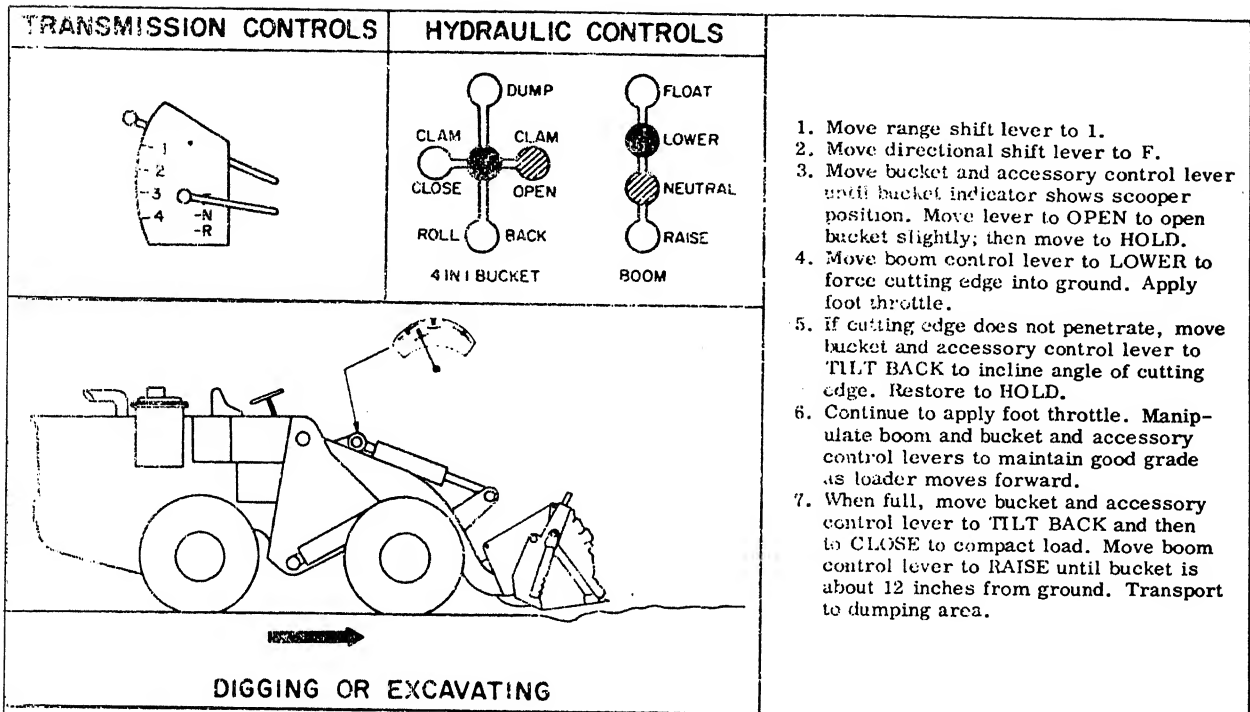
Figure 18. Dumping a load, forward dump method.

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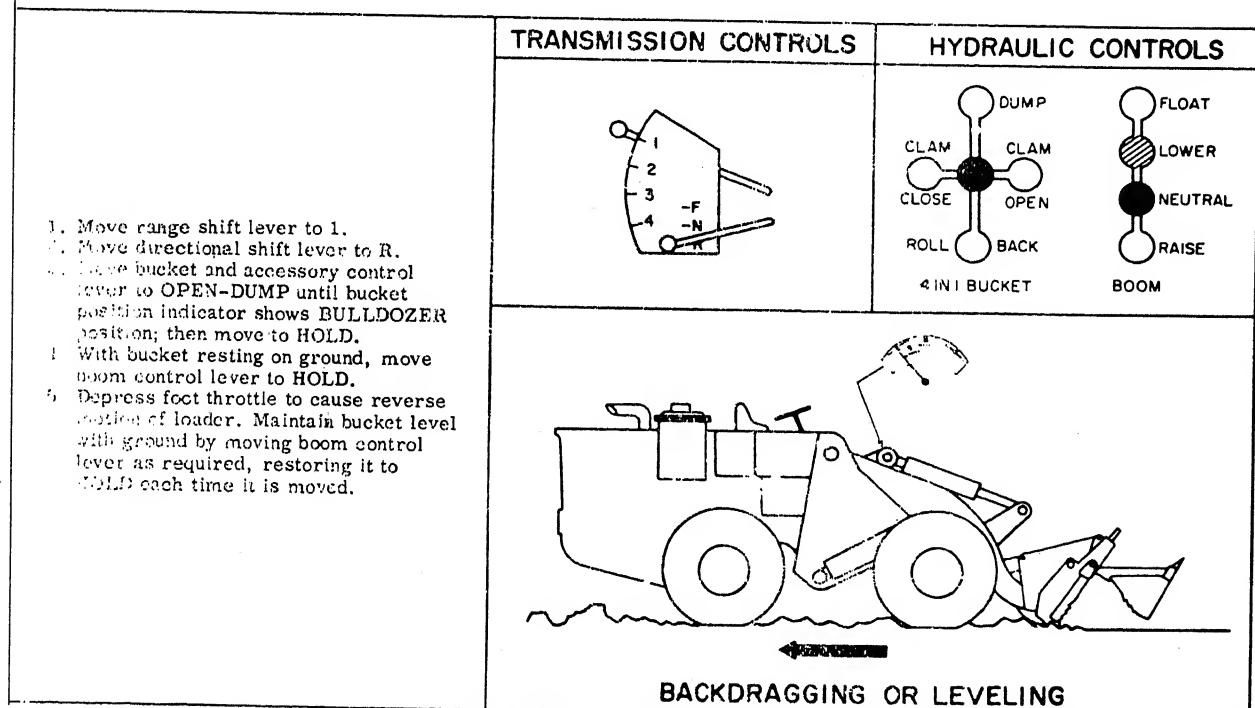
MSC 3805-201-15/12

Figure 19. Dumping a load, bottom dump method.



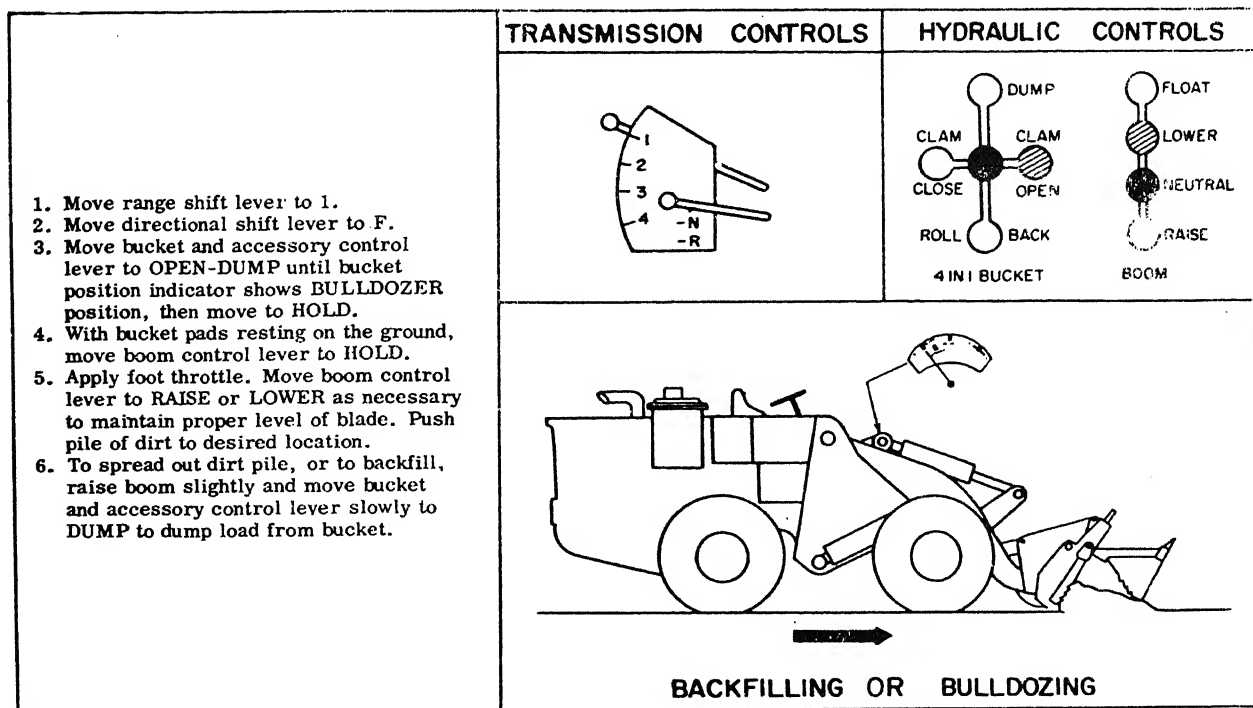
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Figure 20. Digging or excavating.



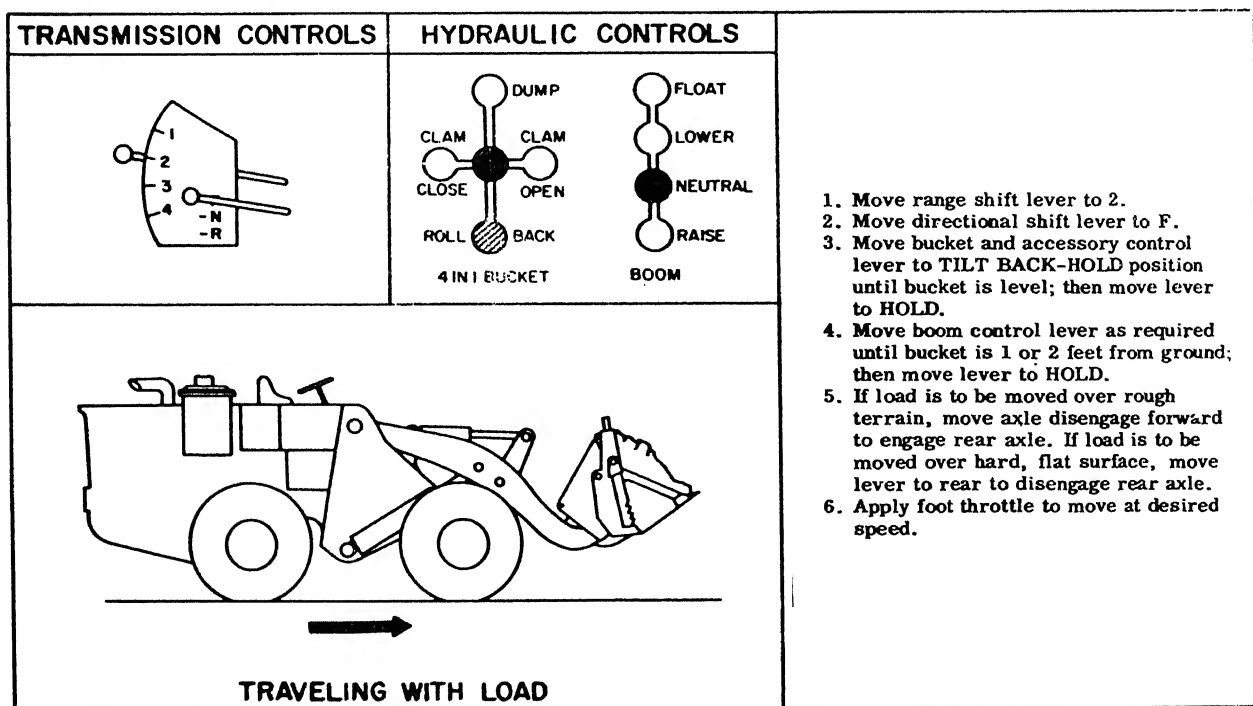
MSC 3805-201-15/21

Figure 21. Backdragging or leveling.



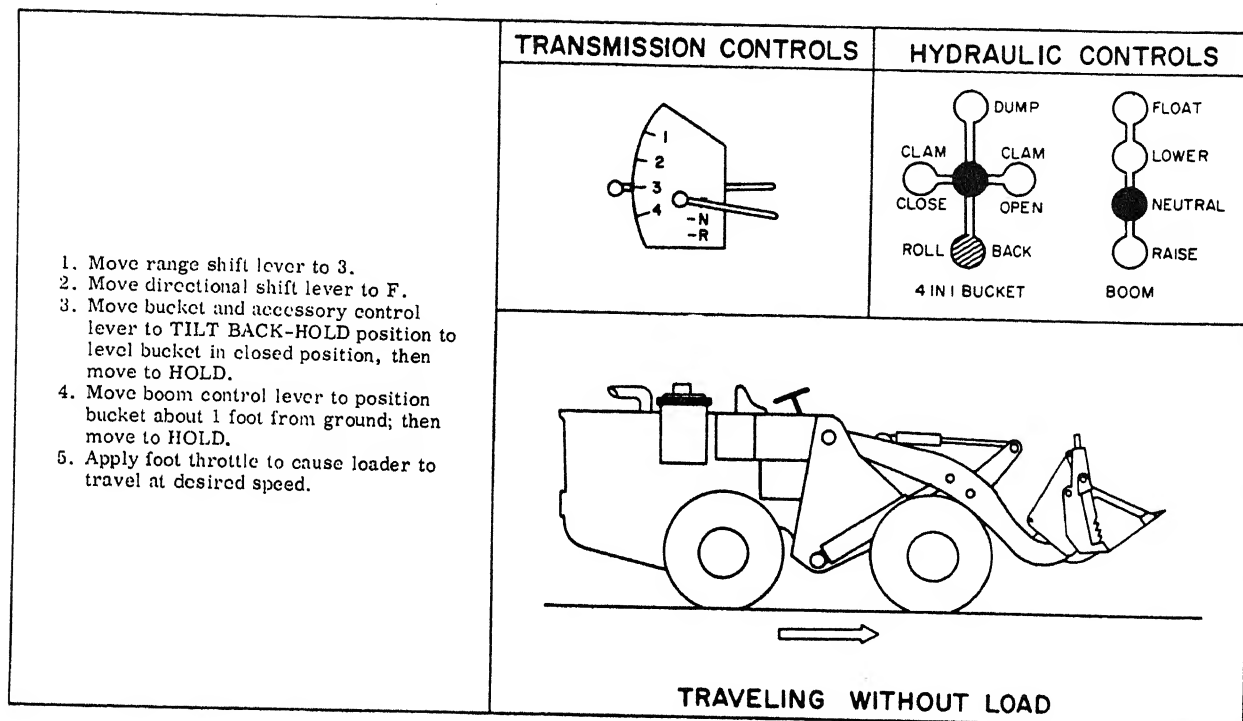
MSC 3805-201-15/22

Figure 22. Backfilling or bulldozing.



MSC 3805-201-15/23

Figure 23. Traveling with a load.



PSC 3805-201-15/24

Figure 24. Traveling without a load.

- (3) Dumping a load, forward dump method. Forward dump a load as shown in figure 18.
- (4) Dumping a load, bottom dump method. Bottom dump a load as shown in figure 19.
- (5) Digging or excavating. Use the loader for digging or excavating as shown in figure 20.
- (6) Backdragging or leveling. Use the loader for backdragging or leveling as shown in figure 21.
- (7) Backfilling or bulldozing. Use the loader for backfilling or bulldozing as shown in figure 22.
- (8) Traveling with a load. Use the loader for transporting a load as shown in figure 23.
- (9) Traveling without a load. Operate the loader without a load as shown in figure 24.

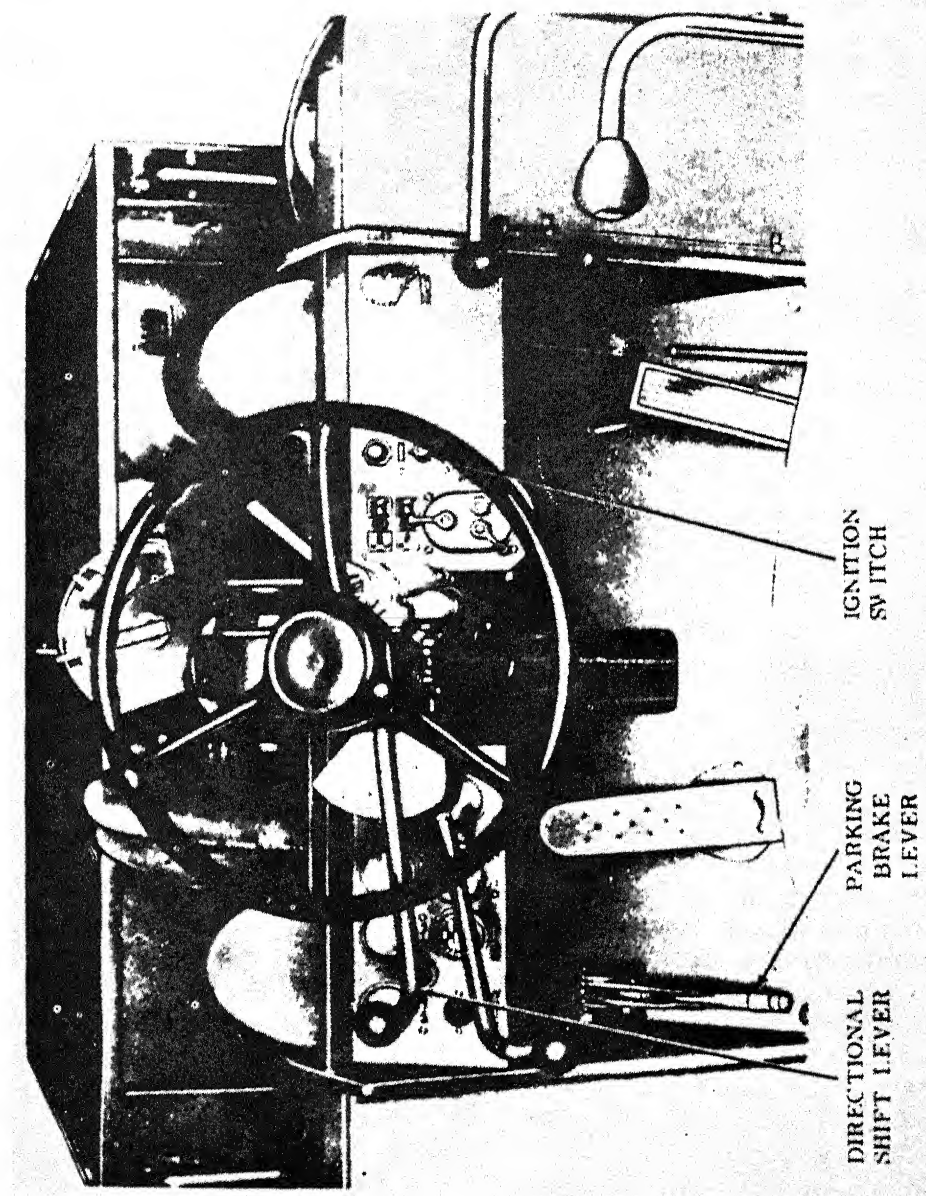
e. *Shutting Down the Equipment.* Shut down the equipment as shown in figure 25.

#### 46. Towing a Trailer With Loader

a. The loader is provided with external air connection points at the back of the loader to provide brake connections to a trailer being towed. Air to one of these connections is controlled by the handbrake valve (11, fig. 10) mounted on the steering column. This connection is marked **SERVICE**. Remove the dummy coupling and connect the **SERVICE** coupling of the trailer to this connection. The second loader connection provides air pressure directly from the reservoir to pressurize the emergency air system of the trailer and is marked **EMERGENCY**. Connect the **EMERGENCY** coupling of the trailer to this connection.

b. A hitch is provided at the rear of the loader to facilitate the connection of a trailer to be towed by the loader. Remove the hitch pin and insert the tongue of the trailer between the stationary hitch parts. Reinsert the pin.

c. When towing a trailer at night, be sure to provide adequate lighting at the rear of the trailer.



1. Park loader in desired location. Apply service brakes and maintain pressure on brake pedal.
2. Move directional shift lever to N.
3. Pull up and forward on parking brake lever. Release pressure on brake pedal.
4. Move boom control lever to FLOW to lower bucket to ground. Move bucket and accessories forward to prevent it to tilt back forward to prevent it from collecting rain, restore forward and accessories control lever to HOLD.
5. Run engine 2 to 5 minutes to dissipate heat from engine.
6. Operate master battery switch to OFF to shut off engine.

MSC 3805-201-15/25

Figure 25. Shutting down the equipment.

## Section IV. OPERATION UNDER UNUSUAL CONDITIONS

### 47. Extreme Cold (Below 0°F.)

*a. General.* Operation of the loader in extremely cold temperatures creates special problems and requires careful inspection and maintenance. Be especially careful not to subject the loader to any sudden shock loads and rough handling which might strain or break the metal parts. Check all controls, linkages, and frame carefully for proper operation. Keep tire pressure uniform at all times. If practical, place a matting of burlap, cardboard, or a nonporous material under the tires when parking the vehicle to keep the tires from freezing to the ground and to protect them from possible damage when the loader is moved. Do not apply the parking brake when the vehicle is parked, but block the wheels to keep the loader from moving. When starting the engine, observe the procedure outlined in paragraph 54c, and allow the engine to idle until it reaches operating temperature before moving the loader. Pay particular attention to readings on all gauges. The oil pressure will indicate pressures higher than normal until the engine oil has had a chance to become warm and circulate freely. The ammeter will register a higher charging rate until the battery is fully charged and the voltage regulator has become warm. For protection and efficient operation of the loader under severe cold weather conditions, carefully observe the instructions given in *b* through *e*, below.

*b. Lubrication.* Make sure that the proper grade and type of lubricant is used at all application points. Refer to the lubrication order (fig. 27) for special lubrication instructions.

*c. Fuel System.* In cold weather, condensation of moisture will cause water to accumulate in tanks, drums, and containers. This water will freeze, form ice crystals, and clog the fuel lines and fuel pump unless the following precautions are taken:

- (1) Remove snow or ice from the fuel tank cap and dispensing equipment before filling the fuel tank.
- (2) Use filter paper or chamois skin to strain the fuel when filling the fuel tank.
- (3) Keep the fuel tank cap tightened to prevent moisture and dirt from entering the fuel tank.
- (4) Keep the fuel tank full when operating

in extremely cold weather to minimize moisture condensation in the tank.

*d. Engine Cooling System.* Inspect the system for leaks and check its general condition. Replace worn, rotted, or damaged hose and hose clamps. Make sure all drain cocks are fully closed. Make sure the cooling system is filled to the proper level with permanent-type anti-freeze if necessary. Make sure the thermostat is operating properly. Keep the hood side panels closed.

*e. Electrical System.*

- (1) Clean the battery and check for cracked or damaged case. Make sure that the holddown and terminal connections are tight. Replace any missing filler caps and make sure vent holes are open. Check the battery electrolyte level; it should be just below the bottom of the filler hole.

**Caution:** Do not add water to the battery in subzero weather, except in small amounts, and only after the engine has been running for 10 minutes and will be run for 45 minutes after the water is added. This will mix the water with the electrolyte and prevent freezing.

- (2) Make sure all switches operate freely, that connections are tight, and that all insulation is free of worn or frayed spots. Do not bend insulation in extreme temperatures; it could crack and cause a short circuit in the electrical system.

*Note.* In extremely cold temperatures, remove the battery from the loader and place it on dry wooden blocks in a warm place until it is to be used again. This will increase the efficiency of the battery from 60 to 95 percent and provide faster cranking speeds.

*f. Brake System.* Immediately after shutting down the loader at any time, open the drain valve at the bottom of the air tank to prevent collected moisture from freezing in the tank.

### 48. Extreme Heat

*a. General.* When operating the loader in extreme heat, pay particular attention to lubrication and the cooling system. Protect the unit from the direct rays of the sun as much as possible.

*b. Lubrication.* Make sure lubricants of the proper grade and type are used at all lubrication points. Refer to the lubrication order (fig. 27) for special lubrication instructions. Increase the frequency of inspections. Pay particular attention to the engine crankcase, air cleaner, and oil filter. Inspect all oil seals for leaks; leakage is more likely in high temperatures.

*c. Cooling System.* Check the engine coolant level more frequently; flush and clean the cooling system frequently to insure proper cooling. Avoid the use of water containing alkali or other substances which will cause rapid formation of scale and rust. Make sure radiator and hydraulic oil cooler fins are clean. Remove any obstructions such as grass, leaves, bugs, or dirt from the radiator and cooler fins with compressed air or water pressure directed toward the rear of the loader. Check the fan belt tension; adjust if necessary. Remove the hood side panels unless dust or sand is present.

*d. Electrical System.* Check the battery electrolyte level daily. Fill to the proper level with distilled water.

#### **49. Dusty or Sandy Areas**

*a. General.* Dust and sand are highly abrasive and penetrate most parts protected under ordinary conditions; therefore, cleanliness is extremely important. Use compressed air to clean inaccessible places. Whenever possible, keep the loader in an enclosure when not in use or cover it with tarpaulins if an enclosure is not available. The following instructions will serve as a guide to prevent undue wear and damage.

*b. Lubrication.* Keep all external parts clean and lubricated. Make sure that all grease fittings are thoroughly cleaned before applying lubricants. Lubricate sparingly, but more frequently. Wipe clean all oily or greasy surfaces so that they do not accumulate dust and sand. Service air cleaners, oil filters, and breather caps more often than under normal circumstances. Make sure the barrel of the air cleaner is free of dust and sand. Refer to the lubrication order (fig. 27) for proper procedures and lubricants. Reduce lubricant intervals from 8 to 4 hours when operating under extreme conditions.

*c. Cooling System.* Inspect the cooling system for leaks and make sure the fan belt is properly adjusted. See that the radiator and hydraulic oil cooler fins and tubing are not

clogged. Use compressed air or water, applied toward the rear of the loader, to dislodge any foreign matter that might have accumulated between the fins and tubes. Keep the side panels closed when not operating the loader.

*d. Fuel System.* Clean around the filler cap and be very careful to keep dust and dirt from entering the tank when refueling. Keep the filler cap vent hole open to insure proper ventilation of the fuel tank.

*e. Electrical System.* Keep all electrical connections and the starter and generator free from dust and sand to avoid short circuits and excessive wear of the commutators and brushes. Wipe clean or blow out the components of the electrical system with compressed air.

#### **50. Salt Water or High Humidity**

*a. General.* Exposed metal corrodes more rapidly in high humidity or salt water areas. Coat unpainted parts with lubricating oil or preservative compound. After working in salt water, wash the loader with fresh water.

*b. Lubrication.* Clean all lubrication fittings thoroughly before applying lubricant.

*c. Electrical System.* Keep all electrical equipment clean and free of corrosion.

*d. Fuel System.* In areas of high humidity, keep fuel tank filled to prevent condensation.

#### **51. High Altitudes**

*a. General.* The power output of an internal combustion engine is reduced at high altitudes. Satisfactory performance can be maintained only by following all operating and maintenance instructions carefully.

*b. Engine.* Clean and service the air cleaner daily to insure maximum intake of air for engine operation.

#### **52. Rough Terrain**

*a.* Rough terrain requires generally slower, more cautious operation of the loader. Use the two lower speed ranges when negotiating difficult areas. Operate the axle disconnect lever to engage both axles to provide maximum control of the operation of the loader.

*b.* Operate the boom control lever to keep the boom raised only as high as necessary to provide proper clearance. Do not raise the bucket unnecessarily high, since this decreases loader stability and lessens visibility.

*c.* When moving down steep inclines, shift



the range shift lever to position number 1 to have the engine assist in braking the movement of the loader. Do not ride the brake pedal,

since this causes transmission disconnect and removes the engine load from the drive train.

## Section V. OPERATION OF AUXILIARY MATERIAL USED IN CONJUNCTION WITH THE END ITEM

### 53. Fire Extinguisher

*a. Description.* The dry chemical fire extinguisher uses a pressurized gas to propel the dry powdered chemical to the source of the fire under control of a lever and handle. It is provided with a pressure gage for a visual indication of the charge condition of the extinguisher. The pointer of the gage must point in the marked area to insure proper extinguisher charge.

*b. Operation.* To operate the extinguisher, pull the pin (4, fig. 26), lift the handle (5), and press the lever (2), to discharge the dry chemical. Direct the chemical at the base of the flame with a side-to-side sweeping motion. When the flame is extinguished, release the handle and lever. Provide for immediate recharging of the extinguisher.

### 54. Primer Discharger

*a. Description.* An ether cartridge engine primer system is provided to aid starting of the loader when the temperature is below 32° F. It consists of a primer discharger (16, fig. 10) and a tube to the intake manifold. The primer discharger houses and punctures the cartridge and temporarily stores the released ether under pressure. The tube conducts the pressurized ether to the manifold when the valve trigger

in the primer discharger is depressed. From here this highly volatile gas is drawn into the cylinder on the intake stroke and detonated at the end of the compression stroke to aid engine starting.

*b. Location.* The primer discharger is mounted in the tool compartment to the right of the operator's seat.

*c. Cold Weather Starting.* To use the ether primer system, follow the instructions given in figure 15, except that before depressing the starter pushbutton, insert an ether cartridge into the primer discharger and turn the cartridge holder, on the top of the discharger, clockwise until the cartridge pierces. The cartridge is completely discharged into the shell when the hissing noise stops. Press the starter pushbutton and press and hold the trigger on the discharger shell to inject ether into the intake manifold. Hold the starter pushbutton depressed until the engine starts, but do not exceed 30 seconds cranking time without allowing a 2 minute period for the cranking motor to cool. Holding the foot throttle depressed three-fourths of the way instead of one-half of the way also aids starting by supplying more fuel to the engine. After starting, turn the cartridge holder counterclockwise to release the cartridge. Remove and disconnect the cartridge.





MSC 3805-201-15/26

- |                 |          |
|-----------------|----------|
| 1 Nozzle        | 4 Pin    |
| 2 Lever         | 5 Handle |
| 3 Pressure gage | 6 Body   |

Figure 26. Fire extinguisher.

## CHAPTER 3

### OPERATOR AND ORGANIZATIONAL MAINTENANCE INSTRUCTIONS

#### Section I. SPECIAL TOOLS AND LUBRICATION

##### 55. Special Tools and Equipment

No special tools or equipment are required for the operator and crew maintenance of the loader. All maintenance procedures can be done with usual mechanic's tools.

##### 56. Lubrication Information

The lubrication order (fig. 27) prescribes lubrication maintenance for the loader. The lubrication order indicates the point to be lubricated, the lubricant, and the lubrication interval.

##### 57. Detailed Lubrication Information

*a. Care of Lubricant.* Always use clean fresh grease or oil for lubricating the loader. Never use grease or oil that has been exposed to dust, dirt, or moisture. Always replace the covers on grease containers to insure that dirt and moisture do not enter.

*b. Points of Application.* Follow the detailed lubrication instructions given in figure 27.

*c. Cleaning.* Wipe all oil cups and grease fittings before applying a grease gun or oil can. Use a cloth dipped in solvent to wipe dirty grease or oil from machined surfaces.

*d. Operation Immediately After Lubrication.* After replacing the oil filter cartridge and adding new oil, run the engine for a few minutes to insure that the filter body is filled with oil. Make sure that the drain plug is tight and not leaking, that the filter case is not leaking around the seal at the filter body, and that there is no

leak around the center pipe at the top. Then stop the engine and check the oil level in the crankcase; if necessary, add oil to bring it to the proper level. When the torque converter or transmission is drained completely and refilled, be sure the oil cooler bleeder valve is open. Start the engine to insure that the oil is circulated to all the points in the unit; close the bleeder valve when a steady stream of oil is discharged from its port. Check the level with the transmission dipstick and add oil if necessary.

##### *e. Service Daily.*

- (1) *Grease fittings.* Use a good grade of chassis grease to lubricate all points indicated on the lubrication order; replace broken or defective grease fittings.
- (2) *Engine and accessories.* Lubricate all engine accessories; check engine crankcase level as indicated on the lubrication order.
- (3) *Air cleaner.* Service the air cleaner and breather cap to insure free breathing of the engine.
- (4) *Battery.* Clean the terminals and coat with vaseline. Be sure that the electrolyte level is up to the top of the mark indicated on the battery. Replenish with distilled water only.

*Note.* A felt washer placed over the battery terminals and under the connector, saturated with light oil, will guard the terminals against corrosion.

# LUBRICATION ORDER

# L05-3805-201-15-1

**LOADER, SCOOP TYPE: DIESEL ENGINE; 4 WHEEL DRIVE,  
REAR WHEEL STEERABLE PNEUMATIC TIRES; 2-1/2  
CU. YD.; W/MULTI-SEGMENT BUCKET (FRANK  
G. HOUGH MODEL H-90CM) W/ENGINE  
CUMMINS MODEL JT-6-B1**

Reference: L0 5-3805-201-15-2 C 9100-SL

Intervals are based on normal hours of operations. Reduce to compensate for abnormal operations and severe conditions. During inactive periods, sufficient lubrication must be performed for adequate preservation.

Clean fittings before lubricating.

Relubricate after washing or fording.

A dotted circle indicates a drain below.

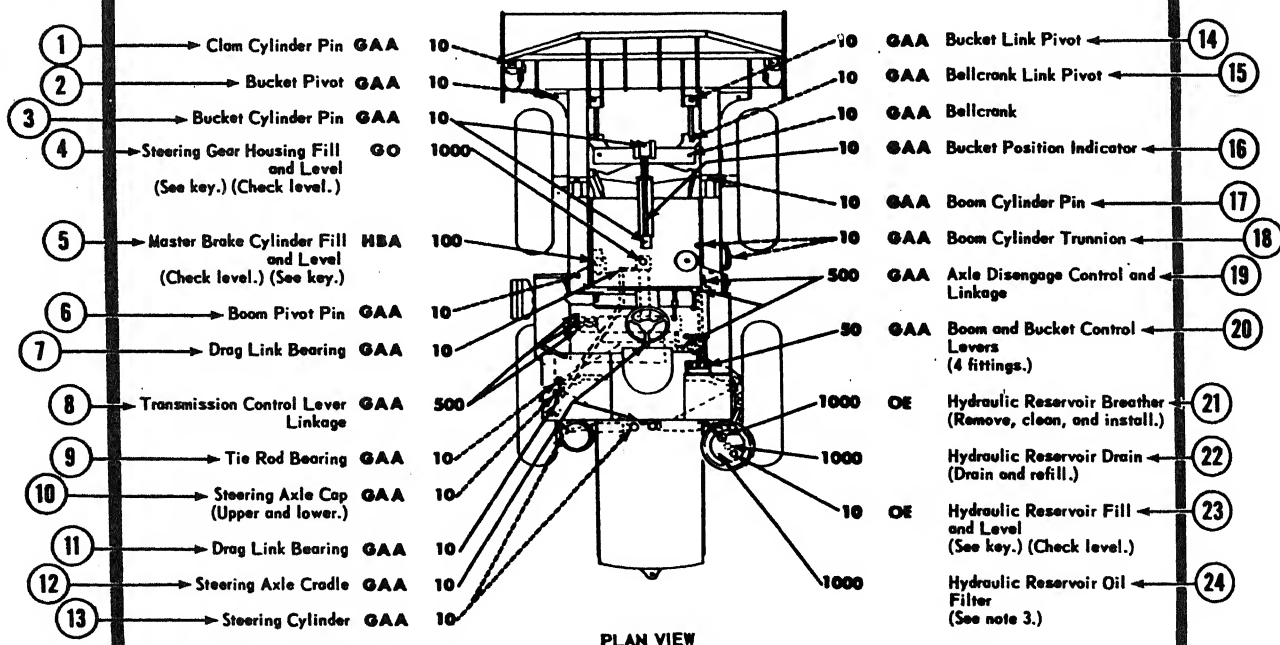
Clean parts with SOLVENT, dry-cleaning, or with OIL, fuel, Diesel. Dry before lubricating.

Lubricate points indicated by dotted arrow shafts on both sides of equipment.

Drain crankcase when hot. Fill and check level.

LUBRICANT • INTERVAL

INTERVAL • LUBRICANT



MSC 3805-201-15/27 ①

Figure 27. Lubrication Order.



# LUBRICATION ORDER

# L05-3805-201-15-2

## LOADER, SCOOP TYPE: DIESEL ENGINE; 4 WHEEL DRIVE, REAR WHEEL STEERABLE PNEUMATIC TIRES; 2-1/2 CU. YD.; W/ MULTI-SEGMENT BUCKET (FRANK G. HOUGH MODEL H-90CM) W/ ENGINE CUMMINS MODEL JT-6-B1

Reference: L0 5-3805-201-15-1 C 9100-SL

Intervals are based on normal hours of operations. Reduce to compensate for abnormal operations and severe conditions. During inactive periods, sufficient lubrication must be performed for adequate preservation.

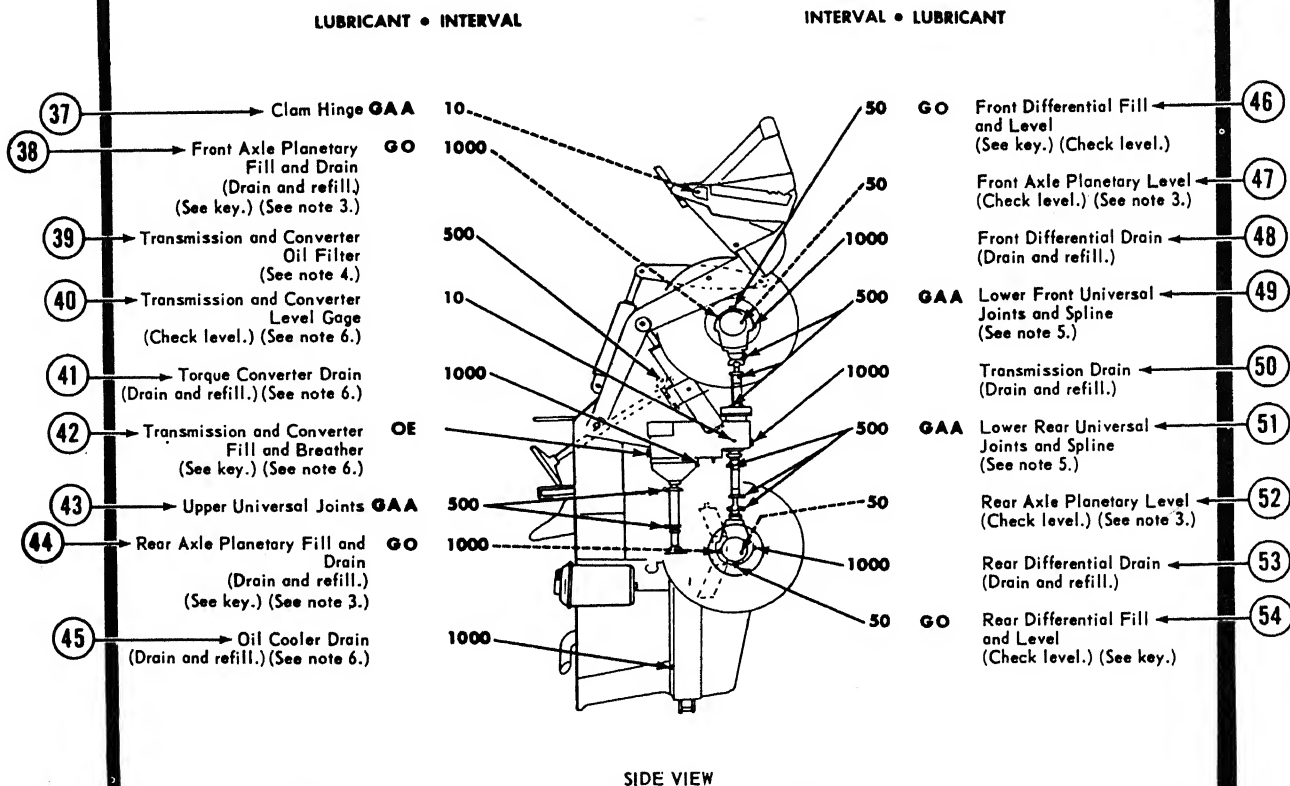
Clean fittings before lubricating.

Relubricate after washing or fording.

Clean parts with SOLVENT, dry-cleaning, or with OIL, Fuel, Diesel. Dry before lubricating.

Lubricate points indicated by dotted arrow shafts on both sides of equipment.

Drain gearcases when hot. Fill and check level.



MSC 3805-201-15/27 ③

Figure 27—Continued.

- KEY -

LUBRICANTS	CAPACITY	EXPECTED TEMPERATURES			INTERVALS	
		Above $\nless 32^{\circ}\text{F}$	$\nless 40^{\circ}\text{F}$ to $-10^{\circ}\text{F}$	$0^{\circ}\text{F}$ to $-65^{\circ}\text{F}$		
OE-OIL, Engine, Heavy Duty		OE 10 or 9110	OE 10 or 9110	OES	Intervals given are in hours of normal operation.	
Oil Can Points						
Transmission and Converter	21 qt					
OES-OIL, Engine, Sub-zero		GO 140	GO 90	GOS		
GO- LUBRICATING OIL, Gear						
Front Axle Planetary	2-5/8 qt ea					
Rear Axle Planetary	2-5/8 qt ea					
Front Differential	22-1/2 qt					
Rear Differential	20-1/2 qt					
GOS-LUBRICATING OIL, Gear, Sub-zero						
GAA-GREASE, Automotive and Artillery		All Temperatures				

NOTES:

1. FOR OPERATION OF EQUIPMENT IN PROTRACTED COLD TEMPERATURES BELOW  $-10^{\circ}\text{F}$ . Remove lubricants prescribed in the key for temperatures above  $-10^{\circ}\text{F}$ . Clean parts with SOLVENT, dry-cleaning. Relubricate with lubricants specified in the key for temperatures below  $-10^{\circ}\text{F}$ .

2. OIL CAN POINTS. Every 50 hours lubricate handbrake, control lever linkage, and all exposed adjusting threads with OE.

3. AXLE PLANETARIES. Every 50 hours rotate wheels until oil level line is horizontal. Check level. Every 1000 hours rotate wheels until drain and fill plug is at bottom center, remove plug, and drain. To fill, rotate wheels until oil level is horizontal, and fill to plug opening.

4. TRANSMISSION AND CONVERTER OIL FILTER. Every 500 hours remove filter element, clean housing, install new element, fill system, operate equipment for 5 minutes, check for leaks. Check transmission oil level and bring to full mark.

5. LOWER UNIVERSAL JOINTS AND SPLINES. Every 500 hours remove plugs from splines, install fitting, lubricate sparingly, remove fitting, and install plugs.

6. TRANSMISSION AND CONVERTER. Every 10 hours check level at transmission level gage and add oil through transmission fill. Every 1000 hours open vent cock to top of oil cooler, drain torque converter, oil cooler, and transmission. Clean breather and magnetic drain plugs. Fill transmission to proper level. With oil cooler vent cock open, run engine at idle speed for 2 minutes with transmission control levers in neutral position, and close vent cock when a steady stream of oil appears. Stop engine. Check transmission oil level and bring to full mark.

Copy of this Lubrication Order will remain with the equipment at all times; instructions contained herein are mandatory.

BY ORDER OF THE SECRETARY OF THE ARMY:

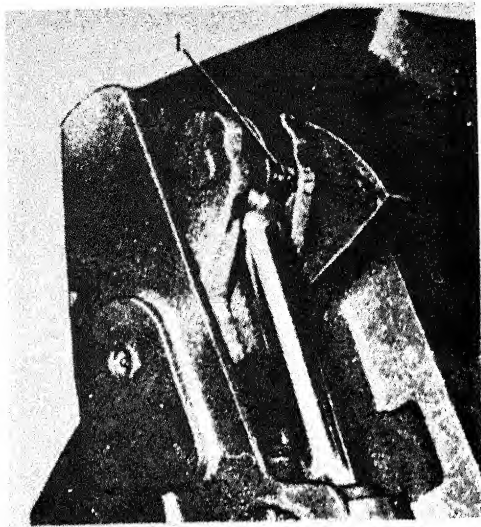
EARLE G. WHEELER,  
General, United States Army,  
Chief of Staff.

OFFICIAL:

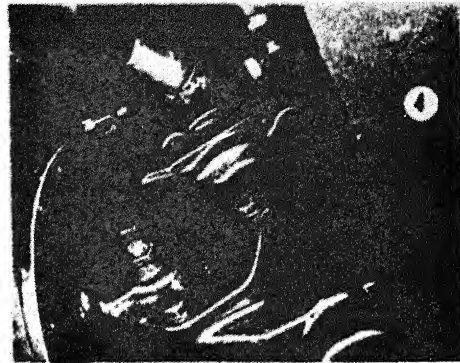
J. C. LAMBERT,  
Major General, United States Army,  
The Adjutant General.

MSC 3805-201-15/27 (4)

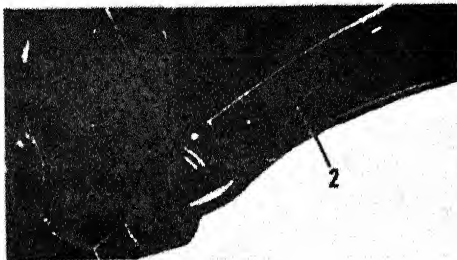
Figure 27—Continued.



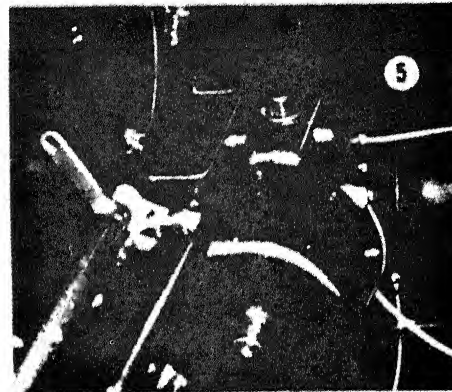
Ref. 1. Clam Cylinder Pin



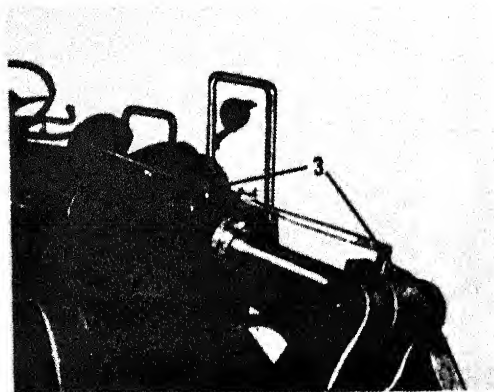
Ref. 4. Steering Gear Housing  
Fill and Level



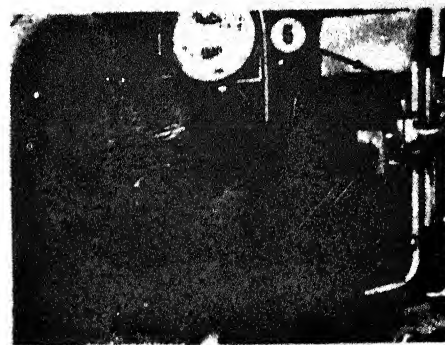
Ref. 2. Bucket Pivo'



Ref. 5. Master Brake Cylinder  
Fill and Level



Ref. 3. Bucket Cylinder Pin

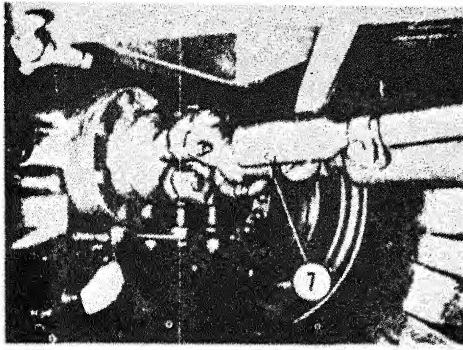


Ref. 6. Boom Pivot Pin

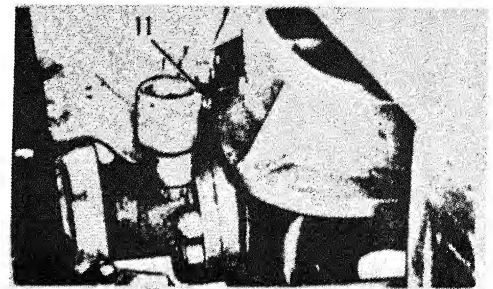
MSC 3805-201-15/27 ⑤

Figure 27—Continued.

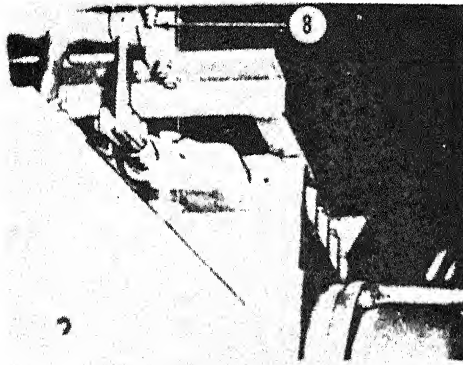




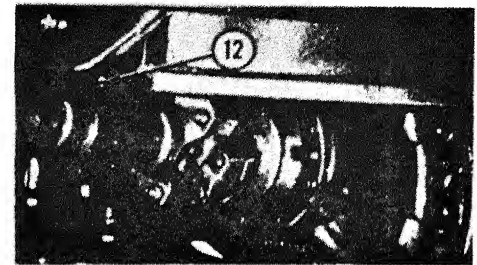
Ref. 7. Drag Link Bearing



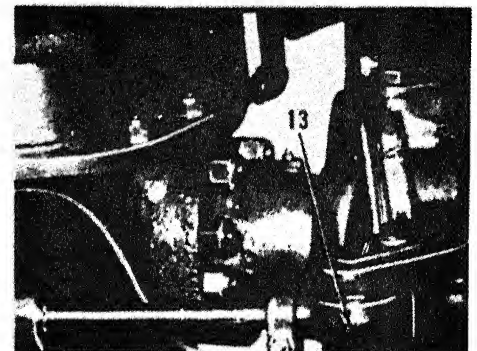
Ref. 11. Drag Link Bearing



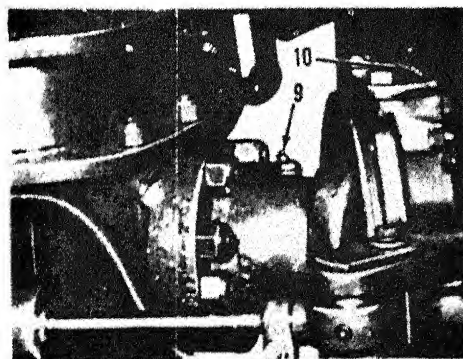
Ref. 8. Transmission Control Lever Linkage



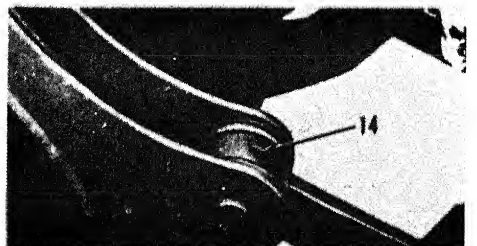
Ref. 12. Steering Axle Cradle



Ref. 13. Steering Cylinder



Ref. 9. The Rod Bearing  
Ref. 10. Steering Axle Cap Upper and Lower

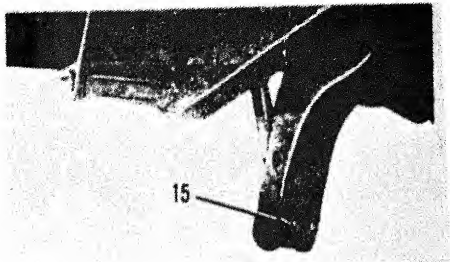


Ref. 14. Bucket Link Pivot

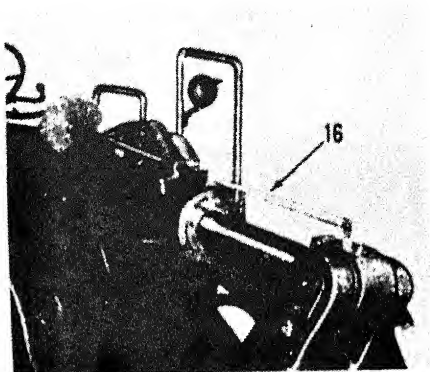
MSC 3805-201-15/27 ⑥

Figure 27—Continued.

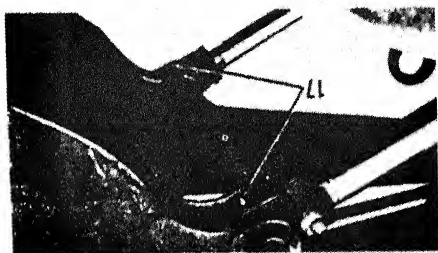




Ref. 15. Bellcrank Link Pivot



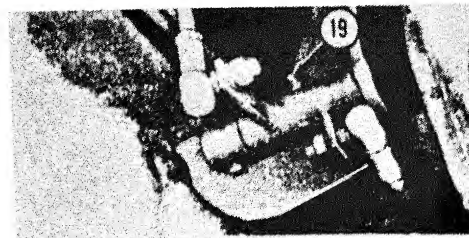
Ref. 16. Bucket Position Indicator



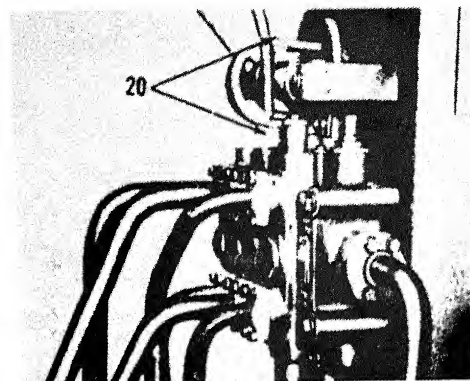
Ref. 17. Boom Cylinder Pin



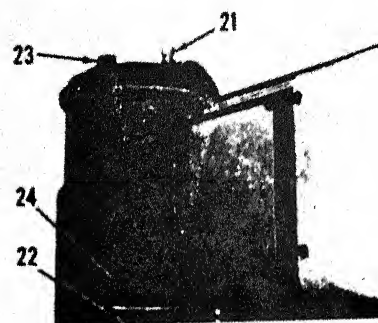
Ref. 18. Boom Cylinder Trunnion



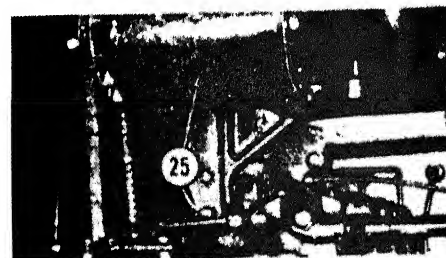
Ref. 19. Axle Disengage Control and Linkage



Ref. 20. Boom and Bucket Control Levers



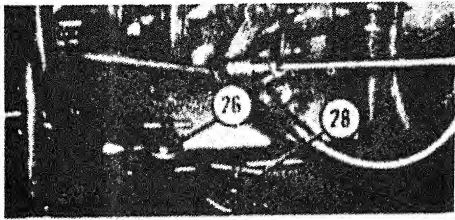
Ref. 21. Hydraulic Reservoir Breather  
Ref. 22. Hydraulic Reservoir Drain  
Ref. 23. Hydraulic Reservoir Fill and Level  
Ref. 24. Hydraulic Reservoir Oil Filter



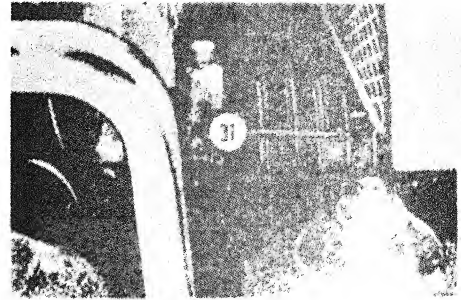
Ref. 25. Generator

MSC 3805-201-15/27 7

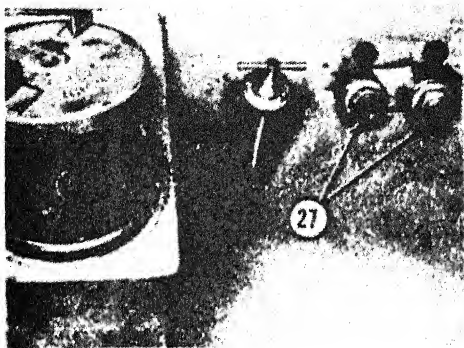
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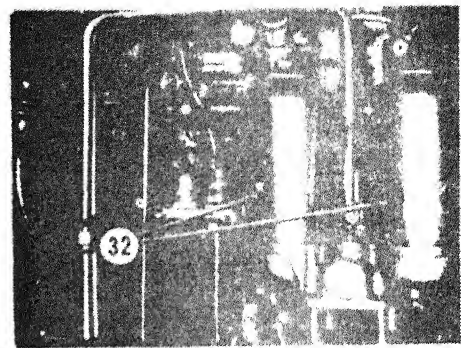
Ref. 26. Crankcase Level Gage  
Ref. 28. Crankcase Fill



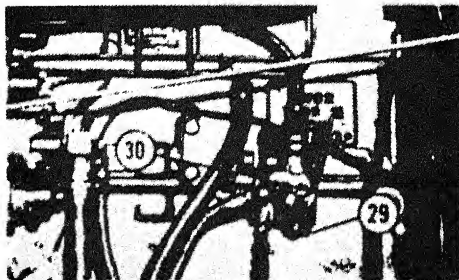
Ref. 31. Fan Hub



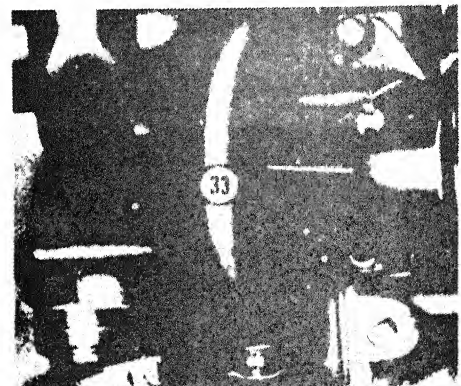
Ref. 27. Crankcase Drain



Ref. 32. Engine Oil Filters



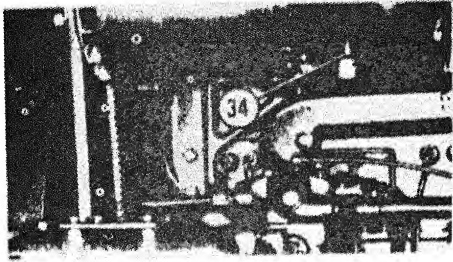
Ref. 29. Aneroid Control Drain  
Ref. 30. Aneroid Control Fill and Level



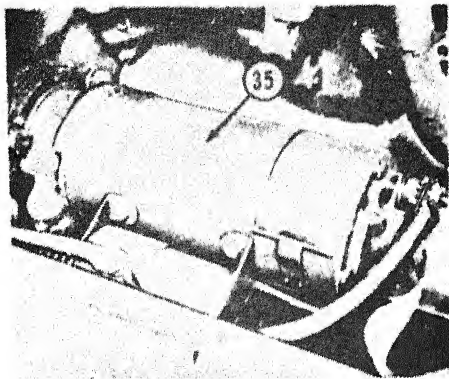
Ref. 33. Water Pump

MSC 3805-201-15/27 (C)

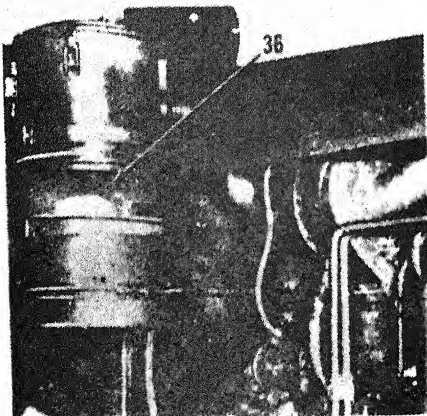
**Figure 27—Continued.**



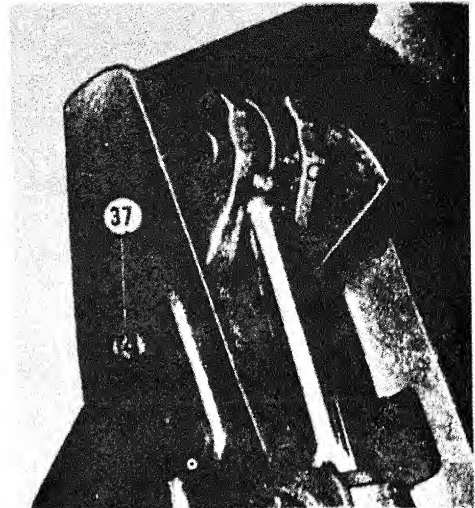
Ref. 34. Crankcase Breather



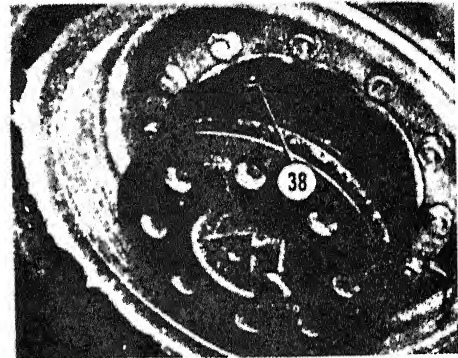
Ref. 35. Starter



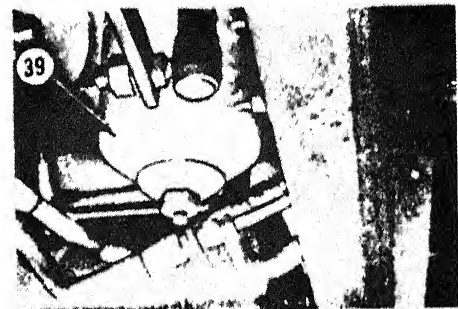
Ref. 36. Front Air Cleaner



Ref. 37. Clam Hinge



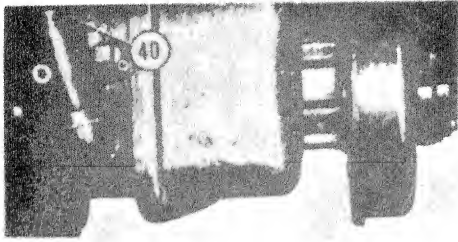
Ref. 38. Front Axle Planetary Fill and Drain



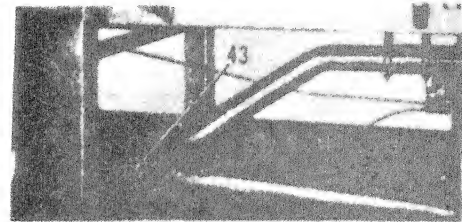
Ref. 39. Transmission and Converter Oil Filter

MS# 3805-201-15/27 ⑨

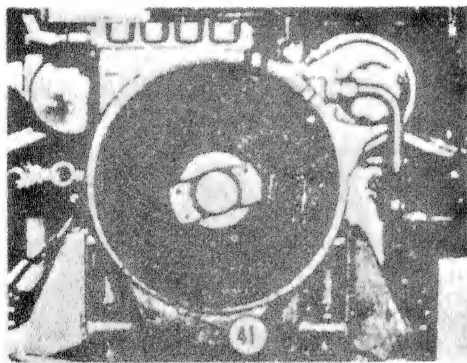
*Figure 27—Continued.*



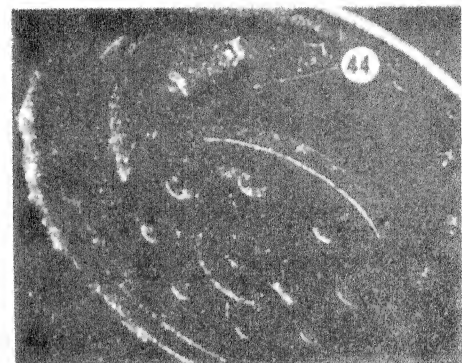
Ref. 40. Transmission and Converter  
Level Gage



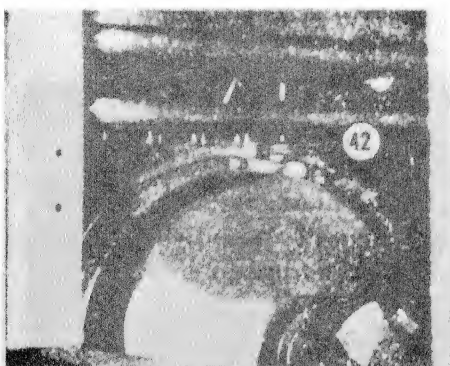
Ref. 43. Upper Universal Joints



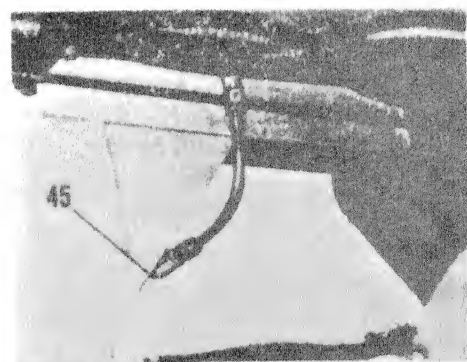
Ref. 41. Torque Converter Drain



Ref. 44. Rear Axle Planetary  
Fill and Drain



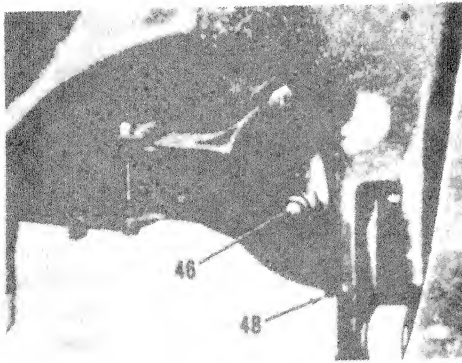
Ref. 42. Transmission and Converter Fill  
and Breather



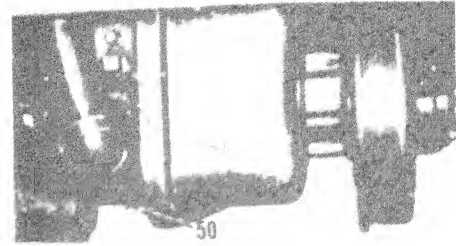
Ref. 45. Oil Cooler Drain

MSC 3805-201-15 27 (10)

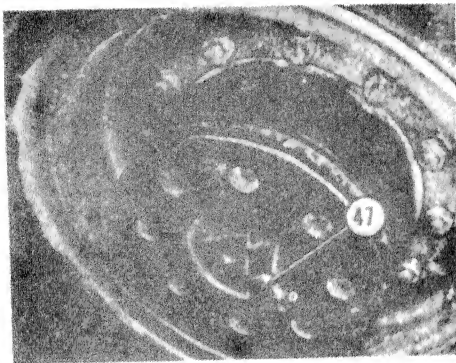
*Figure 27—Continued.*



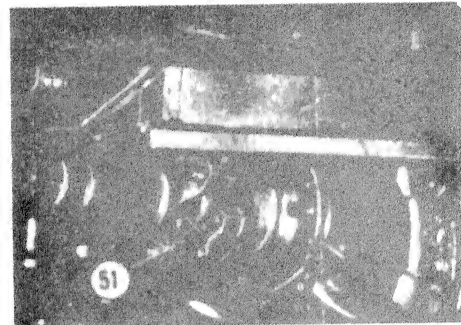
Ref. 46. Front Differential Fill and Level  
Ref. 48. Front Differential Drain



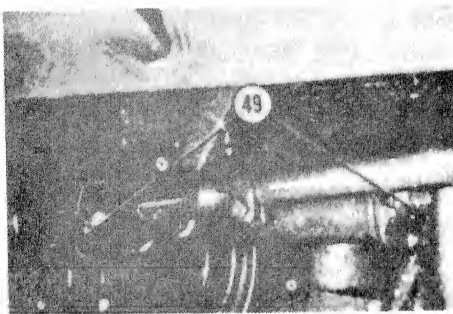
Ref. 50. Transmission Drain



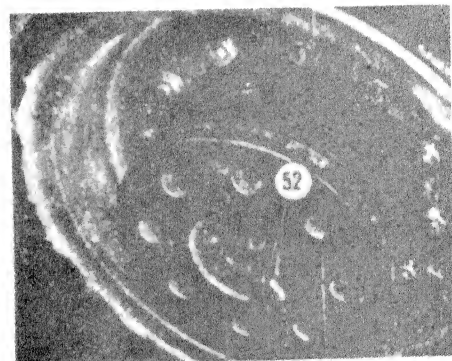
Ref. 47. Front Axle Planetary Level



Ref. 51. Lower Rear Universal Joints  
and Splines



Ref. 49. Lower Front Universal Joints  
and Splines

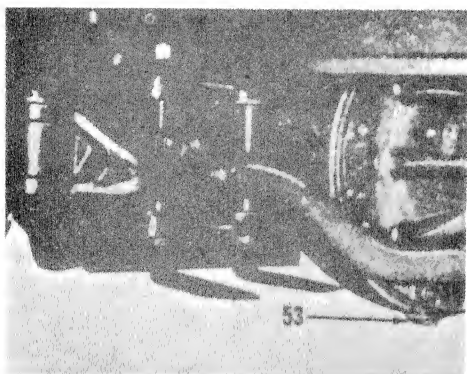


Ref. 52. Rear Axle Planetary Level

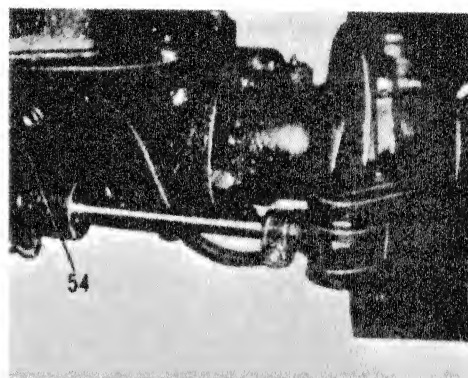
MSC 3805-201-15/27 (11)

Figure 27—Continued.





**Ref. 53. Rear Differential Drain**



**Ref. 54. Rear Differential Fill and Level**

WSC 3805-201-15/27 (12)

*Figure 27—Continued.*

## Section II. PREVENTIVE MAINTENANCE SERVICES

### 58. General

To insure that the loader is ready for operation at all times, it must be inspected systematically, so that defects may be discovered and corrected before they result in serious damage or failure. The necessary preventive maintenance services to be performed are listed and described in paragraphs 59 and 60. The item numbers indicate the sequence of minimum inspection requirements. Defects discovered during operation of the unit will be noted for future correction, to be made as soon as operation has ceased. Stop operation immediately if a deficiency is noted during operation, which would damage the equipment if operation were continued. All deficiencies and shortcomings will be recorded together with the corrective action taken on DA Form 2404 at the earliest possible opportunity.

### 59. Daily Preventive Maintenance Services

This paragraph contains an illustrated tabu-

lated listing of preventive maintenance services which must be performed by the operator. The item numbers are listed consecutively and indicate the sequence of minimum requirements. Refer to figure 28 for the daily preventive maintenance services.

### 60. Quarterly Preventive Maintenance Services

a. This paragraph contains an illustrated tabulated listing of preventive maintenance services which must be performed by organizational maintenance personnel at quarterly intervals. A quarterly interval is equal to 3 calendar months, or 250 hours of operation, whichever occurs first.

b. The item numbers are listed consecutively and indicate the sequence of minimum requirements. Refer to figure 29 for the quarterly preventive maintenance services.

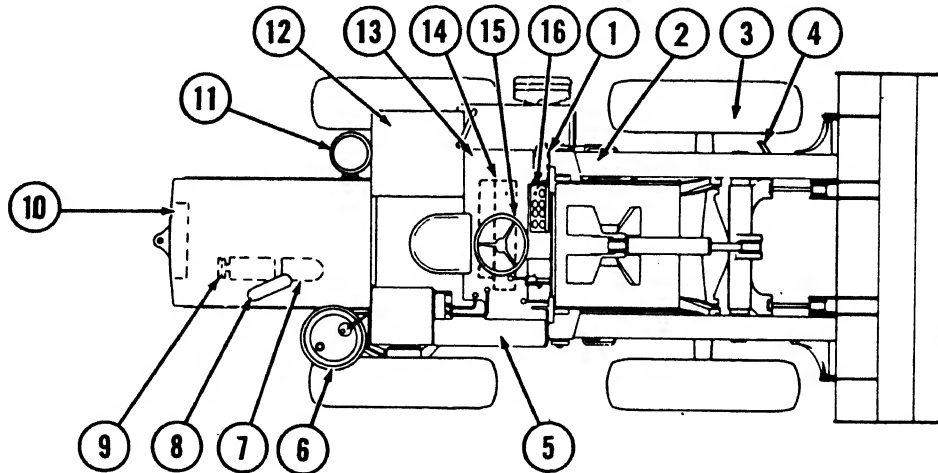
# PREVENTIVE MAINTENANCE SERVICES

## DAILY

TM5-3805-201-15

FRANK G. HOUGH  
MODEL H-90CM

LOADER



LUBRICATE IN ACCORDANCE WITH CURRENT LUBRICATION ORDER		PAR REF
ITEM		
1	<u>TRANSMISSION AND CONVERTER.</u> Check transmission oil level. Add oil as indicated by level gage. Reference current L.O.	212
2	<u>LIGHTS.</u> Check for burned out lamp or lamp units.	
3	<u>TIRES.</u> Check for proper air pressure. Proper air pressure is 45 psi. Replace missing valve caps.	177
4	<u>AIR RESERVOIR.</u> Drain condensation.	
5	<u>FIRE EXTINGUISHER.</u> Check for broken seal.	
6	<u>HYDRAULIC RESERVOIR.</u> Check fluid level. Add fluid as necessary. Reference current L.O.	
7	<u>OIL LEVEL GAGE.</u> Add oil as indicated by level gage. Reference current L.O.	
8	<u>FUEL FILTERS.</u> Drain water and sediment from filter. (Weekly)	
9	<u>V-BELTS.</u> Proper adjustment is a deflection equal to width of belt for each foot of free span. (Weekly)	
10	<u>RADIATOR.</u> Proper coolant level is 2 inches below filler neck.	

MSC 3805-201-15/28 (1)

Figure 28. Daily preventive maintenance services.



ITEM		PAR. REF
11	<u>AIR CLEANER.</u> With engine running check reading on restrictor indicator for necessity of element replacement.	
12	<u>BATTERIES.</u> Tighten loose cables and mountings. Remove corrosion. Inspect for cracks and leaks. Fill to 3/8 inch above the plates. Clean vent hole in filler cap before installing. In freezing weather run engine a minimum of 1 hour after adding water. (Weekly)	
13	<u>PARKING BRAKE.</u> Check for proper operation, brake should hold firmly with 3/4 travel of lever.	
14	<u>SERVICE BRAKES.</u> Check application and operation. Add fluid to master cylinder of power cluster if necessary. (Weekly)	
15	<u>STEERING GEAR.</u> Check for proper operation of steering gear. It should operate freely without binding.	
16	<u>CONTROLS AND INSTRUMENTS.</u> Inspect for damage and loose mounting. With unit operating, check for proper operation. Normal operating readings for instruments are as follows: Engine temperature gage 185° to 185°F. Engine oil pressure gage 30 to 70 psi Transmission clutch oil pressure 180 psi minimum gage Air pressure gage 75 to 105 psi Ammeter should show slight reading on charge side of scale.	

MSC 3805-201-15/28 (2)

Figure 28—Continued.

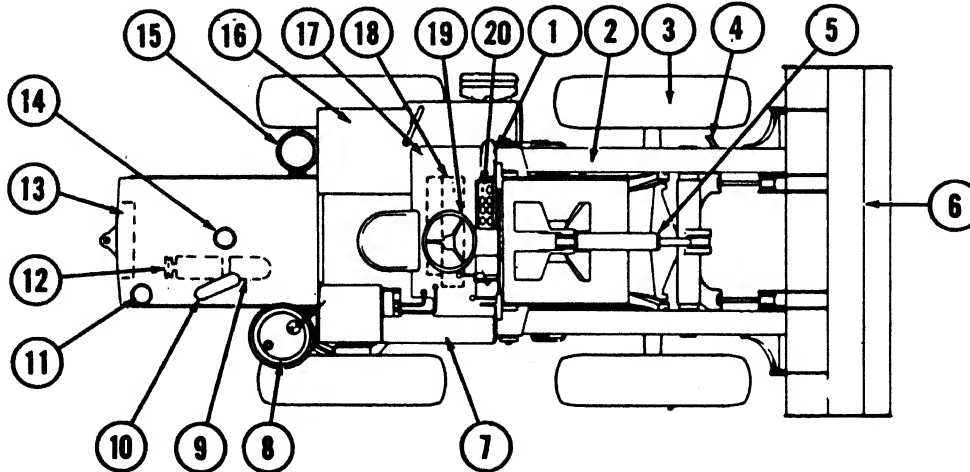
# PREVENTIVE MAINTENANCE SERVICES

## QUARTERLY

TM5-3805-201-15

FRANK G. HOUGH  
MODEL H-80CM

LOADER



LUBRICATE IN ACCORDANCE WITH CURRENT LUBRICATION ORDER

ITEM		PAR REF
1	<b>TRANSMISSION AND CONVERTER.</b> Check transmission oil level. Add oil as indicated by level gage. Reference current L.O.	212
2	<b>LIGHTS.</b> Check for loose or corroded connections and burned out lamp. Tighten or clean loose or corroded connections. Replace a burned out lamp.	142 thru 145
3	<b>TIRES.</b> Check tires for cuts, bruises, imbedded foreign matter, excessive wear, and missing valve caps. Replace missing valve caps. Correct air pressure is 45 psi front and rear.	177
4	<b>AIR RESERVOIR.</b> Check for loose or leaking connections, and damaged air reservoir. Tighten or replace loose or leaking connections. Replace damaged air reservoir. Drain condensation.	188
5	<b>HYDRAULIC CYLINDERS.</b> Check for leaks and insecure mounting.	
6	<b>CUTTING EDGE.</b> Check for chips, bends, broken welds, and excessive wear.	
7	<b>FIRE EXTINGUISHER.</b> Inspect for broken seal. The dry chemical type must be weighed every 6 months. If the weight has decreased to less than 4 1/2 pounds or the pressure is below 125 psi the extinguisher must be replaced.	

MSC 3805-201-15/29 (1)

Figure 29. Quarterly preventive maintenance services.

ITEM	PAR REF
8 <u>HYDRAULIC RESERVOIR.</u> Check fluid level. Add fluid as necessary. Reference current L.O.	205
9 <u>OIL LEVEL GAGE.</u> Add oil as indicated by level gage. Reference current L.O.	
10 <u>FUEL FILTERS.</u> Drain water and sediment from filters. Clean or replace a dirty filter element.	129
11 <u>FUEL TANK.</u> Tighten loose mounting. Replace leaking fuel tank. Replace defective cap gasket. Clean cap vent.	131
12 <u>V-BELTS.</u> Proper adjustment is a deflection equal to width of belt for each foot of free span. Replace worn, frayed or cracked belt.	139 152
13 <u>RADIATOR.</u> Proper coolant level is 2 inches below filler neck. Replace cracked or frayed hose. Replace defective radiator. Remove obstructions in the air passages. Tighten all mounting and leaking connections. Correct cap pressure rating is 4 lbs.	148
14 <u>CRANKCASE, BREATHER.</u> Check breather tube for kinks or obstructions. Clean or replace breather element.	158
15 <u>AIR CLEANER.</u> With the engine running, check reading on restriction indicator for necessity of element replacement.	128
16 <u>BATTERIES.</u> Tighten loose cables and mountings. Remove corrosion. Fill to 3/8 inch above the plates. Clean venthole in filler cap before installing. In freezing weather run engine minimum of 1 hour after adding water. Replace a cracked or leaking battery.	137
17 <u>PARKING BRAKE.</u> Check for proper operation. Brake should hold firmly with 3/4 travel of lever. Adjust if necessary.	175 <del>200</del> 186
18 <u>SERVICE BRAKES.</u> Check application and operation of service brakes. Adjust brakes if power cluster indicator extends more than 3/4 inch. Add fluid to master cylinder of power cluster if necessary.	186a
19 <u>STEERING GEAR.</u> Check for proper operation of the steering gear. It should operate freely without excessive binding. Adjust backlash if necessary.	199
20 <u>CONTROLS AND INSTRUMENTS.</u> Replace damaged instruments. Tighten loose mounting. With the unit operating, check for proper operation. Normal operating readings for instruments are as follows: Engine temperature gage 185° to 185°F. Engine oil pressure gage 30 to 70 psi. Transmission clutch oil pressure gage 180 psi minimum Air pressure gage 75 to 105 psi Ammeter should show slight reading on charge side of scale.	10 thru 25

MSC 3805-201-15/29 (2)

Figure 29—Continued.

## Section III. Troubleshooting

### 61. General

This section provides information useful in diagnosing and correcting unsatisfactory operation or failure of the loader or any of its components. Each trouble symptom stated is followed by a list of probable causes of the trouble. The possible remedy recommended is described opposite the probable cause.

### 62. Engine Fails to Start or Hard to Start

<i>Probable cause</i>	<i>Possible remedy</i>
Restricted air intake	Clean air intake of restrictions.
Out of fuel or fuel shutoff valve closed.	Refuel; turn on ignition to open shutoff valve.
Leaks in fuel lines	Repair and eliminate air in fuel lines.
Restricted fuel lines	Clean fuel lines.
Pressure regulator faulty or improperly set.	Repair or replace fuel pressure regulator (par. 238).
Plugged injector spray holes.	Clean injectors (par. 134b).
Broken fuel pump drive shaft.	Replace fuel pump drive shaft (par. 238).
Scored gear pump or worn gear.	Replace gear or scored pump body (par. 238).
Loose injector inlet or drain connections.	Tighten connections (par. 133).
Engine due for overhaul	Overhaul engine (par. 224-236).
Incorrect valve and injection timing.	Correct valve and injection timing (par. 134c).
Binding in turbocharger	Repair turbocharger (par. 163). Check for restricted oil level.

### 63. Engine Misses or Runs Erratically

<i>Probable cause</i>	<i>Possible remedy</i>
Air leaks in fuel lines	Repair and eliminate air in fuel lines.
Restricted fuel lines	Clean fuel lines.
Long idle periods	Decrease idling time, if possible.
Valve leakage	Regrind valves; clean off carbon deposits (par. 235).
Injectors need adjustment	Adjust injectors (par. 134c).

### 64. Low Power or Loss of Power

<i>Probable cause</i>	<i>Possible remedy</i>
Restricted air intake	Clean air intake of restriction.
High exhaust back pressure	Clean exhaust system to insure free breathing.

<i>Probable cause</i>	<i>Possible remedy</i>
Poor quality fuel	Use better grade of fuel.
Leaks in fuel lines	Repair leaks in fuel lines.
Restriction in fuel line	Clean fuel line of restriction.
Pressure regulator faulty or set wrong.	Replace pressure regulator (par. 157).
Defective turbocharger	Repair or replace turbocharger (par. 163).
Plugged injector spray holes	Remove and clean injectors (par. 134b).
Scored gear pump or worn gears.	Replace gears or scored pump body (par. 238).
Wrong injector cups	Replace with correct injector cups (par. 237).
Improperly adjusted throttle linkage.	Repair or adjust linkage; check for free movement (par. 168).
Dirty filters and screens	Clean filters and screens (par. 129).
Long idle periods	Reduce idling time.
Valve leakage	Grind valves (par. 235).
Broken or worn piston rings.	Replace piston rings (par. 231).
Incorrect bearing clearances.	Correct bearing clearances.
Main bearing bore out of alignment.	Align main bearing bore (par. 230).
Incorrect valve or injection timing.	Correct valve or injection timing.
Worn or scored pistons or liners.	Replace piston or liners, (par. 228, 231).
Injectors need adjustment	Adjust injectors (par. 134c).

### 65. Engine Dies

<i>Probable cause</i>	<i>Possible remedy</i>
Out of fuel or fuel shutoff valve defective.	Refuel; test and replace defective fuel shutoff valve.
Poor quality fuel	Use better quality fuel.
Broken fuel pump drive shaft.	Replace fuel pump drive shaft (par. 238).
Governor weights assembled incorrectly.	Reassemble governor weights correctly (par. 238).
Injectors need adjustment	Adjust injectors (par. 134c).
Binding in turbocharger	Repair or replace turbocharger (par. 163).

### 66. Excessive Smoke When Idling

<i>Probable cause</i>	<i>Possible remedy</i>
Restricted fuel lines	Clean fuel lines.
Plugged injector spray holes.	Remove and clean injectors (par. 134b).
Worn injector cups	Replace injector cups (par. 237).
Long idle periods	Decrease idling time, if possible.

<i>Probable cause</i>	<i>Possible remedy</i>
Broken or worn piston rings	Replace piston rings (par. 231).
Engine due for overhaul	Overhaul engine (pars. 224-236).
Incorrect valve and injection timing.	Correct valve and injection timing (par. 165).
Worn or scored liners or pistons.	Replace liners or pistons (pars. 228 and 231).

## 67. Excessive Smoke Under Load

<i>Probable cause</i>	<i>Possible remedy</i>
Restricted air intake	Clean restrictions from air intake.
High exhaust back pressure	Clean exhaust system to insure free breathing.
Poor quality fuel	Use a better grade of fuel.
Restricted fuel lines	Clean restrictions from fuel lines.
Plugged injector spray holes.	Clean injectors (par. 134b).
Wrong injector cups	Replace with right injector cups (par. 237).
Long idle periods	Reduce idling time.
Engine overloaded	Eliminate overload.
Broken or worn piston rings	Replace piston rings (par. 231).
Incorrect valve and injection timing.	Correct valve and injection timing (par. 134c).
Worn or scored liners or pistons.	Replace liners or pistons (pars. 228 and 231).
Injectors need adjustment	Adjust injectors (par. 134c).

## 68. Engine Cannot Reach Governed RPM

<i>Probable cause</i>	<i>Possible remedy</i>
Air leaks in fuel lines	Correct air leaks in fuel lines.
Pressure regulator faulty or incorrectly set.	Repair pressure regulator (par. 238).
Improperly adjusted throttle linkage.	Repair or adjust linkage; check for free movement.
Defective turbocharger	Repair or replace turbocharger (par. 163).

## 69. Engine Fuel Knocks

<i>Probable cause</i>	<i>Possible remedy</i>
Poor quality fuel	Use fuel with higher cetane rating.
Air leaks in fuel lines	Repair and eliminate air in fuel lines.
Insufficient coolant	Add coolant.
Engine overloaded	Eliminate overload.
Injectors need adjustment	Adjust injectors (par. 134b).

## 70. Mechanical Knocks

<i>Probable cause</i>	<i>Possible remedy</i>
Insufficient coolant	Add coolant.
Engine overloaded	Eliminate overload.

<i>Probable cause</i>	<i>Possible remedy</i>
Faulty vibration damper	Replace vibration damper (pars. 227 and 238).
Unbalanced or loose fly-wheel.	Balance or replace fly-wheel (par. 236).
Broken or worn piston rings.	Replace piston rings (par. 231).
Incorrect bearing clearances	Correct bearing clearances (par. 230).
Engine due for overhaul	Overhaul engine (pars. 224-236).
Damaged main or connecting rod bearings.	Replace main or connecting rod bearings (pars. 230 and 231).
Tooth broken in gear train	Replace gear (pars. 224 and 236).
Loose mounting bolts	Tighten mounting bolts.
Worn or scored pistons or liners.	Replace pistons or liners or both (pars. 228 and 231).

## 71. Excessive Engine Vibration

<i>Probable cause</i>	<i>Possible remedy</i>
Faulty vibration damper	Replace vibration damper (par. 236).
Unbalanced or loose fly-wheel.	Balance or replace fly-wheel (par. 236).
Main bearing bore out of alinement.	Aline main bearing bore (par. 230).
Engine due for overhaul	Overhaul engine (pars. 224-226).
Loose mounting bolts	Tighten mounting bolts.

## 72. Throttle Has Flat Spot

<i>Probable cause</i>	<i>Possible remedy</i>
Pressure regulator faulty or incorrectly set.	Repair pressure regulator (par. 238).

## 73. Excessive Fuel Consumption

<i>Probable cause</i>	<i>Possible remedy</i>
Restricted air intake	Clean air intake of restriction.
High exhaust back pressure	Clean exhaust system to insure free breathing.
Poor quality fuel	Use better grade of fuel.
Restricted fuel line	Clean fuel line of restriction.
Pressure regulator faulty or incorrectly set.	Repair pressure regulator (par. 238).
Plugged injector spray holes	Remove and clean injectors (par. 134b).
Wrong injector cups	Replace injector cups (par. 237).
Cracked injector body or cup.	Replace injector body or cup (par. 237).
Mutilated injector cup pre-formed packing.	Replace injector cup pre-formed packing (par. 237).
Engine overloaded	Eliminate overload.
Incorrect bearing clearances.	Correct bearing clearances (pars. 224-236).
Engine due for overhaul	Overhaul engine (pars. 224-236).

## 74. Poor Deceleration

<i>Probable cause</i>	<i>Possible remedy</i>
Restricted fuel line.....	Remove restriction from fuel line.
Incorrectly assembled fuel pump idle springs.	Reassemble fuel pump idle springs correctly.

## 75. Erratic Idle Speeds

<i>Probable cause</i>	<i>Possible remedy</i>
Leaks in fuel lines.....	Repair and eliminate air in fuel lines.
Plugged injector spray holes	Remove and clean injectors (par. 134b).
Incorrectly assembled fuel pump idle springs.	Reassemble fuel pump idle springs correctly (par. 238).
Injectors need adjustment....	Adjust injectors (par. 134c).

## 76. Surging Governed Speed

<i>Probable cause</i>	<i>Possible remedy</i>
Air leaks in fuel lines.....	Repair leaks in fuel lines.
Injectors need adjustment....	Adjust injectors (par. 134c).

## 77. Excessive Lubricating Oil Consumption

<i>Probable cause</i>	<i>Possible remedy</i>
External and internal leaks	Repair oil leaks.
Wrong grade oil for weather conditions.	Substitute with correct grade.
Engine due for overhaul....	Overhaul engine (pars. 224-236).
Worn or scored liners or pistons.	Replace liners or pistons (pars. 228-231).

## 78. Crankcase Sludge

<i>Probable cause</i>	<i>Possible remedy</i>
Dirty lube oil strainer.....	Clean lube oil strainer (par. 155).
Faulty thermostat.....	Replace with new thermostat (par. 149).
Dirty filters and screens.....	Clean filters (par. 155).
Long idle periods.....	Decrease idling time.
Lube oil needs changing....	Change lube oil.

## 79. Lubrication Oil Dilution

<i>Probable cause</i>	<i>Possible remedy</i>
External or internal fuel leaks.	Repair fuel leaks.
Loose injector inlet or drain connections.	Tighten connections.
Cracked injector body or cup.	Replace with new injector body or cup (par. 237).
Mutilated injector cup pre-formed packing.	Replace with new pre-formed packing (par. 237).
External and internal oil leaks.	Repair oil leaks.
Faulty cylinder oil control	Correct with new pistons or liners or both.
Internal water leaks.....	Repair water leaks.
Long idle periods.....	Decrease idling time.

## 80. Low Lubricating Oil Pressure

<i>Probable cause</i>	<i>Possible remedy</i>
Oil suction line restriction..	Clean suction lines of all restrictions (par. 234).
Faulty oil pressure regulator.	Replace regulator (par. 157).
Incorrect bearing clearances.	Correct or replace bearings for proper clearance (pars. 224-236).
Engine due for overhaul....	Overhaul engine (pars. 224-236).
Damaged main or connecting rod bearings.	Replace main or connecting rod bearings (pars. 230 and 231).

## 81. Coolant Temperature too Low

<i>Probable cause</i>	<i>Possible remedy</i>
Faulty thermostat.....	Replace thermostat (par. 149).

## 82. Coolant Temperature too High

<i>Probable cause</i>	<i>Possible remedy</i>
High exhaust back pressure.	Clean exhaust system to insure free breathing.
Crankcase oil level low.....	Fill crankcase with proper grade of oil.
Insufficient coolant.....	Add coolant.
Worn water pump.....	Replace water pump (par. 150).
Faulty thermostat.....	Replace thermostat (par. 149).
Damaged water hose.....	Replace water hose.
Loose fan belts.....	Tighten or replace fan belts (par. 152).
Clogged water passages.....	Clear water passages with cooling system cleaner.
Radiator core openings clogged with dirt.	Blow dirt from core with compressed air or water pressure.
Air in cooling system.....	Drain and refill cooling system.
Exterior water leaks.....	Repair water leaks.
Engine overloaded.....	Eliminate overload.
Engine exterior caked with dirt.	Remove dirt from engine exterior.

## 83. Lubricating Oil too Hot

<i>Probable cause</i>	<i>Possible remedy</i>
Insufficient coolant.....	Refill to correct coolant level.
Worn water pump.....	Replace water pump (par. 150).
Faulty thermostat.....	Replace thermostat (par. 149).
Damaged water hose.....	Replace water hose.
Loose fan belts.....	Tighten or replace fan belts (par. 152).
Clogged water passages.....	Clean water passages.
Insufficient quantity of oil	Fill crankcase to proper level.
Clogged oil filter.....	Clean or replace oil filter (par. 155).

<i>Probable cause</i>	<i>Possible remedy</i>
Defective lubricating oil pump.	Repair or replace lubricating oil pump (par. 234).
Clogged oil cooler.....	Clean oil cooler.
Radiator fins clogged with dirt.	Clean radiator fins.
Engine overloaded.....	Eliminate overload.
Exterior of engine caked with dirt.	Remove dirt from engine exterior.

## 84. Piston Liner and Ring Wear

<i>Probable cause</i>	<i>Possible remedy</i>
Air leaks between cleaner and engine.	Repair and eliminate air leaks.
Clogged oil passages.....	Clean oil passages with compressed air.
Restricted oil suction tubes or screens.	Clean restriction from oil suction tubes and screens (par. 234).
Defective lubricating oil pump.	Repair or replace lubricating oil pump (par. 234).
Crankcase out of oil.....	Fill crankcase with proper grade of oil.
Engine overloaded.....	Eliminate overload.
Lube oil needs changing....	Change lube oil (par. 154).
Broken or worn piston rings.	Replace piston rings (par. 231).
Engine due for overhaul....	Overhaul engine (pars. 224-236).
Worn or scored pistons or liners.	Replace pistons or liners or both (pars. 228-231).

## 85. Excessive Wear of Bearings and Journals

<i>Probable cause</i>	<i>Possible remedy</i>
Air leaks between cleaner and engine.	Repair and eliminate air leaks.
Dirty lube oil filter.....	Remove and clean lube oil filter (par. 155).
Clogged oil passages.....	Clean oil passages with compressed air.
Defective lubricating oil pump.	Repair or replace lubricating oil pump (par. 224).
Oil suction tubes or screens restricted.	Clean restriction from oil suction tubes and screens.
Crankcase out of oil.....	Fill crankcase with proper grade of oil.
Engine overloaded.....	Eliminate overload.
Lube oil needs changing....	Change lube oil.
Incorrect bearing clearances.	Correct bearing clearances or replace bearings (pars. 230 and 231).
Excessive crankshaft end clearance.	Correct crankshaft end clearance (par. 230).
Main bearing bore out of alignment.	Realine bearing bores (par. 230 and 231).
Engine due for overhaul....	Overhaul engine (pars. 231-236).

<i>Probable cause</i>	<i>Possible remedy</i>
Damaged main or connecting rod bearings.	Repair or replace main or connecting rod bearings (par. 230).

## 86. Worn Valves and Guides

<i>Probable cause</i>	<i>Possible remedy</i>
Air leaks between cleaner and engine.	Repair and eliminate air leaks.
Dirty lube oil filter.....	Clean lube oil filter (par. 155).
Clogged oil passages.....	Clean oil passages with compressed air.
Restricted oil suction tubes or screens.	Clean restrictions from oil suction tubes and screens (par. 234).
Crankcase out of oil.....	Fill crankcase with proper grade of oil.
Engine overloaded.....	Eliminate overload.
Defective lubricating oil pump.	Repair or replace lubricating oil pump (par. 234).
Lube oil needs changing....	Change lube oil.
Valve leakage.....	Adjust valves or grind seats (par. 235).
Engine due for overhaul....	Overhaul engine (pars. 224-236).
Incorrect valve and injection timing.	Correct valve and injection timing (par. 134c).

## 87. Hissing at Air Intake Tubing Joints When Engine is in Operation

<i>Probable cause</i>	<i>Possible remedy</i>
Loose or split tubing.....	Tighten or replace tubing.
Cracked intake manifold or loose flange.	Repair or replace manifold (par. 167).
Defective intake manifold gasket.	Replace manifold gasket (par. 167).

## TRANSMISSION

### 88. Engine Running, But Loader Will Not Move

<i>Probable cause</i>	<i>Possible remedy</i>
Brakes not released.....	Release brakes.
Forward and reverse lever disengaged.	Engage lever.
Linkages disconnected.....	Insure that all linkages are connected.
Transmission oil level too low.	Add oil.
Defective control valve.....	Repair or replace.
Broken shaft or gear, frozen bearing, or defective seal.	Overhaul transmission (par. 257).

### 89. Loader Moves Slowly Without Sufficient Power at Wide Open Throttle

<i>Probable cause</i>	<i>Possible remedy</i>
Transmission oil level low.	Add oil.
Plugged filter.....	Replace filter cartridge.
Torque converter binding....	Repair bind in torque converter (par. 257).

## 90. Loader Reaches Rated Power in One Speed or Direction, But Loses Power in Opposite Speed or Direction

<i>Probable cause</i>	<i>Possible remedy</i>
Forward and reverse lever linkage not functioning properly.	Adjust linkage (par. 172a). Repair or replace defective clutch (par. 257).
Faulty transmission clutch	

## 91. Transmission Oil Overheating

Oil level too low	Add oil.
Loader being operated at improper speed.	Shift to proper speed.
Restricted oil cooler, oil filter, or lines.	Remove restriction.
Oil cooler fins clogged with dirt and dust.	Blow or wash dirt out with compressed air or water pressure.
Faulty torque converter	Repair converter (par. 257).

## DRIVE AXLES

## 92. Excessive Whine in the Differential

<i>Probable cause</i>	<i>Possible remedy</i>
Differential oil low or dry	Fill to proper level.
Maladjusted or worn gears	Adjust or replace gears (par. 266).

## 93. Excessive Noise When Shifting From Forward to Reverse

<i>Probable cause</i>	<i>Possible remedy</i>
Badly worn pinion and ring gear.	Replace pinion and ring gear (par. 266).
Pinion and ring gear out of adjustment.	Adjust pinion and ring (par. 266).
Loose drive shafts	Tighten drive shafts.

## 94. Excessive Noise in Final Drives

<i>Probable cause</i>	<i>Possible remedy</i>
Dry, worn, or broken planetary gears.	Fill with proper lubricant; repair or replace defective parts (pars. 264 and 265).
Dry or badly worn bearings.	Inspect for damaged oil seals; fill with proper lubricant; replace defective parts (pars. 264 and 265).
Excessive looseness or end play.	Raise wheel and check end play; tighten or repair wheel, hub or bearings (pars. 264 and 265).

## STEERING SYSTEM

## 95. Slow or Hard Steering

<i>Probable cause</i>	<i>Possible remedy</i>
Worn or defective steering control valve.	Repair or replace steering control valve (par. 263).

<i>Probable cause</i>	<i>Possible remedy</i>
Restricted hydraulic lines or ports.	Clean lines; remove restrictions.
Worn hydraulic pump	Repair or replace pump (par. 246).
Bent or binding tie rod	Straighten, repair, or replace steering tie rod (par. 264).
Defective steering cylinder	Repair or replace steering cylinder (par. 201).
Worn or binding trunnions	Adjust or replace trunnion bearings (par. 264).
Steering gear adjustment too tight.	Readjust steering gear (pars. 199 and 263).

## 96. Jerky Steering

<i>Probable cause</i>	<i>Possible remedy</i>
Steering cylinder piston packing too tight.	Loosen piston packing.
Air in hydraulic lines	Repair and eliminate air leakage.
Dented steering cylinder or distorted rod.	Replace cylinder (par. 201).
Restricted or worn steering control valve.	Clean, repair, or replace control valve (par. 263).

## 97. Steering Surges or Runs Away

<i>Probable cause</i>	<i>Possible remedy</i>
Steering control valve sticking or damaged centering springs.	Clean control valve; replace damaged or broken parts (par. 263).
Defective or restricted relief valve.	Repair or replace relief valve (par. 263).

## 98. Leaks at Steering Cylinder

<i>Probable cause</i>	<i>Possible remedy</i>
Packing gland too loose.	Tighten packing gland.
Worn or mutilated packings.	Replace packings.
Scored piston rod	Replace cylinder (par. 201).
Loose or broken connections.	Tighten or replace connections.
Cracks in cylinder cap or cylinder.	Replace cylinder (par. 201).

## 99. Steering Valve Sticks

<i>Probable cause</i>	<i>Possible remedy</i>
Weak or broken spring in valve.	Replace spring (par. 263).
Low pressure setting.	Reset pressure (par. 202).
Dirt or foreign matter in valve.	Remove valve and clean (par. 263).
Worn, scored, or mutilated seat.	Replace valve seat (par. 263).

## 100. Steering Wheel Free Play Excessive

<i>Probable cause</i>	<i>Possible remedy</i>
Lash adjuster out of adjustment.	Adjust wheel lash or free play (par. 199).



## BRAKE SYSTEM

### 101. Correct Air Pressure, But Brakes Will Not Apply

<i>Probable cause</i>	<i>Possible remedy</i>
Restricted air line-----	Remove restriction.
Defective treadle valve-----	Repair or replace treadle valve (par. 254).
Leaking air piston rings-----	Replace air piston rings (par. 253).
Faulty power cluster cylinder cups.	Replace power cluster cylinder cups (par. 254).
Leak in brake lines-----	Repair brake lines.
Leak in wheel cylinders-----	Replace cups and pistons (pars. 260-262).
Faulty air pressure gage-----	Replace faulty air pressure gage.

### 102. Stroke Indicator Pin on Power Cluster Extends Beyond Two Inches

<i>Probable cause</i>	<i>Possible remedy</i>
Brakes need adjusting at the shoes.	Adjust brakes (par. 186a).
Air in hydraulic brake system.	Bleed hydraulic brake system (par. 186b).
Leak in hydraulic system-----	Repair leak in hydraulic system (par. 204).
Low fluid level in power cluster.	Fill power cluster to proper level.

### 103. Brakes Lock or Drag After Several Applications

<i>Probable cause</i>	<i>Possible remedy</i>
Restricted air or hydraulic line.	Remove restriction.
Faulty power cluster or wheel cylinders.	Repair or replace power cluster or wheel cylinders (par. 256, 260, or 262).
Broken return springs at brake assemblies.	Replace return springs (pars. 260 and 262).
Frozen or rusted brake shoe pivots.	Clean and lubricate brake shoe pivots (par. 260, 262).

### 104. Brakes Will Not Apply

<i>Probable cause</i>	<i>Possible remedy</i>
No air pressure-----	Check pneumatic system.
Defective treadle valve-----	Repair or replace treadle valve (par. 254).
Defective air compressor-----	Repair or replace air compressor (par. 253).
Defective power cluster-----	Replace or repair defective power cluster (par. 256).
Broken air or hydraulic line.	Repair line.

### 105. Full Brake Hydraulic Pressure (1500 PSI) Cannot Be Developed

<i>Probable cause</i>	<i>Possible remedy</i>
Faulty power cluster-----	Repair or replace power cluster (par. 256).
Low air pressure-----	Refer to paragraph 108.
Faulty treadle valve-----	Repair or replace treadle valve (par. 254).

### 106. Hydraulic System Requires Frequent Bleeding

<i>Probable cause</i>	<i>Possible remedy</i>
Low fluid level in power cluster.	Keep power cluster filled to the top.
Defective power cluster piston cups.	Replace power cluster piston cups (par. 256).
Badly scored hydraulic cylinder in power cluster.	Repair or replace power cluster (par. 256).

### 107. Excessive Pressure Indicated on Gage

<i>Probable cause</i>	<i>Possible remedy</i>
Faulty air compressor governor.	Adjust, repair, or replace air compressor governor (par. 253).
Faulty pressure gage-----	Repair or replace pressure gage.

### 108. Air Compressor Does Not Supply Adequate Pressure

<i>Probable cause</i>	<i>Possible remedy</i>
Excessive carbon in compressor cylinder head or discharge line.	Clean carbon from compressor (par. 253).
Leaking discharge valve-----	Clean or replace discharge valve and seat (par. 253).
Excessively worn compressor.	Overhaul compressor (par. 253).
Intake valve stuck open-----	Clean or replace intake valve (par. 253).
Leak in cylinder head gasket.	Replace cylinder head gasket (par. 253).
Dirty discharge valves and seats.	Clean or replace discharge valves and seats (par. 253).

### 109. Noisy Compressor Operation

<i>Probable cause</i>	<i>Possible remedy</i>
Excessive carbon in the head or discharge line.	Clean carbon from cylinder head and discharge line.
Insufficient lubrication	Clean oil supply hose and compressor of restrictions.
Worn or burned out bearings.	Replace bearings (par. 253).
Excessive wear of pistons, cylinders, wrist pins, and connecting rods.	Replace worn parts (par. 253).

### 110. Compressor Passes Excessive Oil

<i>Probable cause</i>	<i>Possible remedy</i>
Excessive wear.....	Replace all worn parts.
Excessive oil pressure to compressor.	Correct engine oil pressure.
Compressor piston rings improperly installed.	Install piston rings correctly (par. 253).

### 111. Parking Brake Lever Will Not Operate

<i>Probable cause</i>	<i>Possible remedy</i>
Frozen lever joints.....	Oil to free lever joints.
Rusted or frozen brake mechanism.	Remove, clean, and free brake mechanism.

### 112. Parking Brake Will Not Hold

<i>Probable cause</i>	<i>Possible remedy</i>
Lever adjustment too loose.....	Adjust lever (par. 168).
Shoes need replacement.....	Replace shoes.
Grease on linings.....	Use solvent to wash grease from linings.
Broken rod end or clevis.....	Replace rod or clevis.

## MAIN HYDRAULIC SYSTEM

### 113. Cylinders Work Slowly at Rated Engine RPM

<i>Probable cause</i>	<i>Possible remedy</i>
Restricted lines and fittings.	Clean lines and fittings of restrictions.
Oil passing cylinder piston.....	Replace piston packings, pistons, or entire cylinder (pars. 248, 249, and 250).
Dented cylinder tube.....	Replace cylinder tube.
Distorted piston rod.....	Replace piston rod.
Blowby in control valve.....	Replace valve.
Faulty relief valve.....	Clean and adjust valve.

### 114. Boom Lever Will Not Hold in Position

<i>Probable cause</i>	<i>Possible remedy</i>
Weak or broken detent spring.	Replace detent spring (par. 247).
Worn detent cover or poppets.	Repair or replace control valve (par. 247).

### 115. Bucket and Accessory Control Lever Does Not Return to Neutral

<i>Probable cause</i>	<i>Possible remedy</i>
Dirt or burrs in valve bore.....	Overhaul or replace control valve (par. 247).
Binding or distorted control rod or linkage.	Lubricate or replace control rod.
Weak or broken valve spring.	Repair or replace control valve (par. 247).

### 116. Bucket Will Not Lift Rated Load

<i>Probable cause</i>	<i>Possible remedy</i>
Oil passing cylinder piston.....	Replace piston rings, piston, or entire cylinder (par. 249).
Blowby in control valve.....	Replace control valve (par. 247).
Faulty relief valve.....	Clean and adjust relief valve (par. 247).
Damaged or distorted piston rod or cylinder tube.	Replace defective piston rod or tube (par. 249).

### 117. Boom Descends With Control Valve in Hold

<i>Probable cause</i>	<i>Possible remedy</i>
Faulty control valve.....	Replace control valve (par. 247).
Blowby in cylinders.....	Replace piston or piston packings (par. 248).

### 118. Valve Spool Leaks at Seals

<i>Probable cause</i>	<i>Possible remedy</i>
Defective or worn seal.....	Replace seal (par. 247).
Scored valve spools.....	Replace valve (par. 247).

### 119. Piston Rods Leak at Glands

<i>Probable cause</i>	<i>Possible remedy</i>
Loose packing gland.....	Tighten packing gland.
Defective oil seal.....	Replace oil seal (pars. 248, 249, and 250).
Badly scored piston rod.....	Replace piston rod (pars. 248, 249, and 250).
Compressed and faulty packing.	Replace packing (pars. 248, 249, and 250).

### 120. Excessive Foaming in Hydraulic Reservoir

<i>Probable cause</i>	<i>Possible remedy</i>
Poor quality hydraulic oil.....	Refill with nonfoaming type oil.
Too little oil in system.....	Fill reservoir to proper level.

### 121. Cylinders Chatter When in Operation

<i>Probable cause</i>	<i>Possible remedy</i>
Air in hydraulic system	Bleed the system of air.
Packings too tight	Loosen packing gland slightly; lubricate packings with hydraulic oil.
Dented cylinder tube	Replace cylinder tube (pars. 248, 249, and 250).
Distorted piston rod	Replace piston rod (pars. 248, 249 and 250).

## Section IV. RADIO INTERFERENCE SUPPRESSION

### 122. Definition

a. *Interference.* The term "interference" as used herein applies to electrical disturbances in the radio frequency range which are generated by the loader and which may interfere with the proper operation of radio receivers or other electronic equipment.

b. *Interference Suppression.* The term "interference suppression" as used herein applies to the method used to eliminate or effectively reduce radio interference generated by the electrical components of the loader.

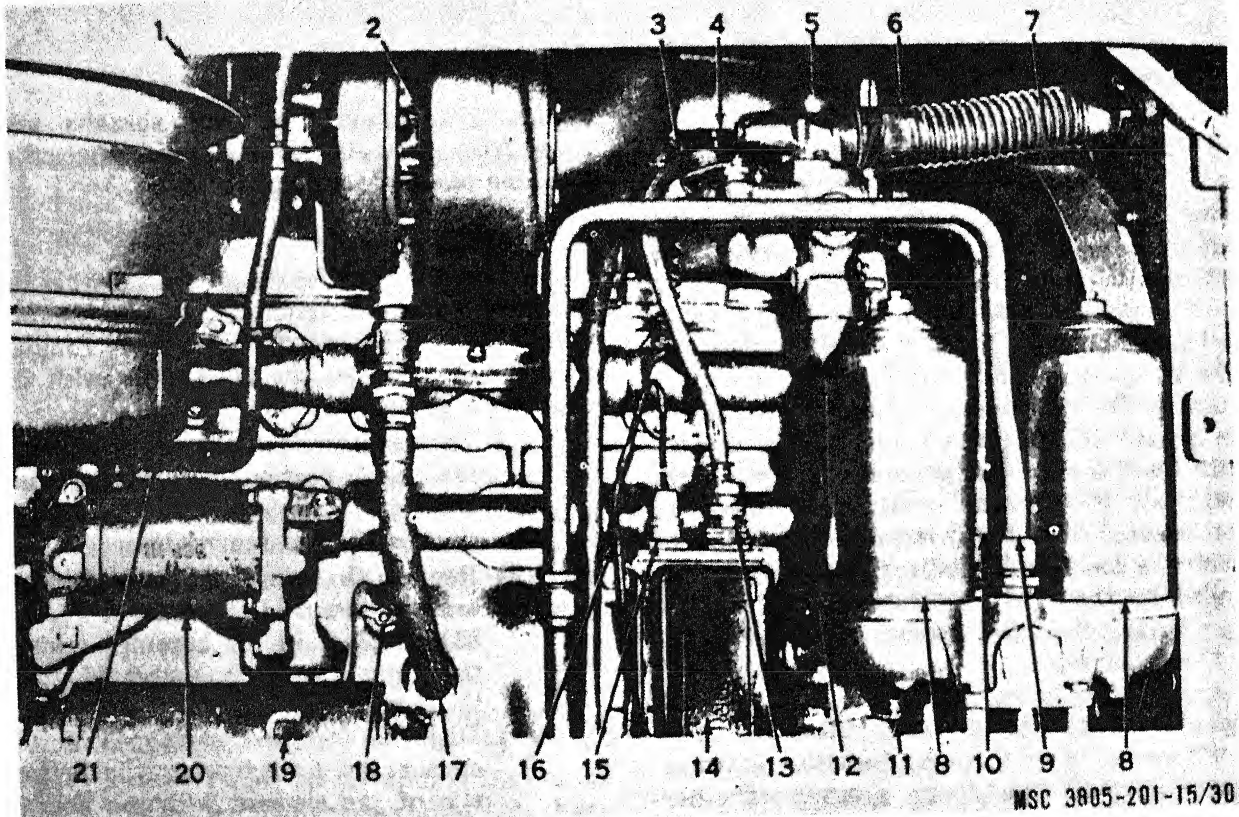
### 123. Purpose

The tactical importance of effective interference suppression cannot be stressed too greatly. Since electrical disturbances generated

by the loader are composed partly of electrical waves in the radio frequency range, they must be suppressed for two important reasons. First, they will interfere with proper operation of the friendly radio net, and second, they will enable the enemy to locate the equipment and its associated units.

### 124. General Sources of Interference

Generally, radio interference is generated anywhere a spark occurs or where a high-frequency current is present. A spark is a small amount of current jumping an air gap in response to the force of a relatively high voltage. The gasoline engine ignition system is a common source. Magneto breaker points, generator commutators, relay contacts, and static charges



- |                            |                     |                                 |                                 |
|----------------------------|---------------------|---------------------------------|---------------------------------|
| 1 Air cleaner              | 6 Radiator hose     | 12 Water bypass tube            | 18 Block drain cock             |
| 2 Turbocharger             | 7 Fan guard         | 13 Receptacle                   | 19 Starting motor               |
| 3 Shielded generator cable | 8 Engine oil filter | 14 Voltage regulator            | 20 Oil cooler                   |
| 4 Generator                | 9 Upper tube        | 15 Receptacle                   | 21 Turbocharger oil supply hose |
| 5 Water outlet connection  | 10 Upper tube       | 16 Battery cable                |                                 |
|                            | 11 Oil drain cock   | 17 Turbocharger oil return hose |                                 |

Figure 30. Left side of engine.

on the frame are other common sources which in some way must be suppressed.

### 125. General Methods to Attain Proper Suppression

Essentially, suppression is attained by providing a low resistance path to ground for stray currents. The methods used to attain suppression include shielding the ignition and high-frequency wires, grounding the frame with bonding straps, using capacitors and resistors where necessary.

### 126. Replacement of Suppression Components

*a. General.* When replacing suppression components, always replace them with identical parts to provide proper interference suppression. Take care to obtain a firm metal-to-metal contact between all shields, lockwashers, and

electrical leads. Be sure all connections are clean and tight.

*b. Shielded Generator Cable.* Replace the shielded generator cable (3, fig. 30) that connects the generator (4) and voltage regulator (14) as follows:

- (1) Remove the left engine side panel from the loader.
- (2) Disconnect the connector that connects the upper end of the generator cable to the receptacle on the generator (4). Disconnect the connector that connects the lower end of the generator cable to the receptacle (13) on the voltage regulator (14); remove the cable.
- (3) Install a new shielded generator cable, connecting it to the mating connectors of the generator and voltage regulator.
- (4) Install the left engine side panel.

## Section V. FUEL SYSTEM

### 127. General

*a.* The fuel system consists of a fuel tank (8, fig. 31), two-stage, fuel filter (1 and 2), fuel pump (5), electric shutoff valve on the fuel pump, fuel supply manifold and connections, injectors, fuel drain manifold and connections, and fuel return lines. The fuel is drawn by the fuel pump through the tank-to-filter hose (4), through the first and either of the second-stage filters to the fuel pump, through the filter-to-pump hose (3). As the result of the throttle setting and the internal governor operation, the fuel pump controls the pressure at which the fuel is supplied to the injectors. The injectors meter the fuel, and the injection timing is controlled by the engine camshaft. Excess fuel from the injectors and the fuel pump is returned to the fuel tank.

*b.* A primer discharger is mounted inside the tool compartment to the right side of the operator's compartment to aid cold weather starting. It contains and punctures a pressurized ether-filled cartridge which forces the ether vapor through a line to a nozzle located in the intake manifold.

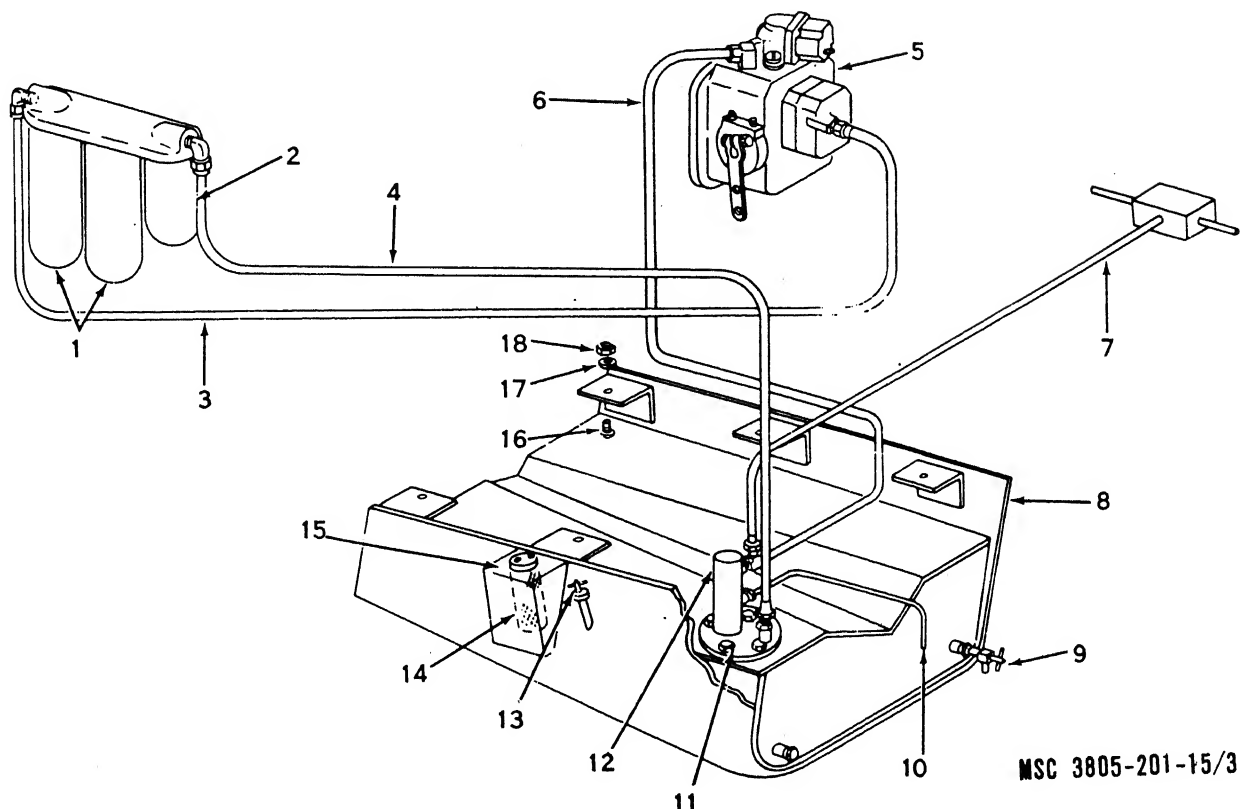
*c.* The dry-element type air cleaner (1, fig. 30) is mounted on the rear of the battery box. The air cleaner filters the air before it is drawn into the cylinders on the intake stroke of the

piston. This filtering prevents abrasive particles from damaging cylinder walls and other machine parts of the engine.

### 128. Air Cleaner

*a. Servicing.* Service the air cleaner when the indicator of the restriction indicator (1, fig. 32) covers the window when the engine is running at fast idle. Service the air cleaner with the engine stopped as follows:

- (1) Thoroughly clean the cover (3) and the upper portion of the air cleaner housing. Loosen the cover holddown clamps (2) and remove the cover.
- (2) Remove the wing bolt and gasket assembly that hold the element (8, fig. 33) in place in the housing; remove the inner cover (6), gasket (7), and the element.
- (3) Dislodge the dust entrapped in the element by first tapping the bottom rim of the element with the heel of the hand; then blow out the element from the clean air side with a jet of clean, dry compressed air. Apply air so that the paper pleating inside the element will not rupture. Wash the element in a solution of warm water and nonsudsing detergent. Flush with



MSC 3805-201-15/31

- |                         |                          |                         |                  |
|-------------------------|--------------------------|-------------------------|------------------|
| 1 Secondary fuel filter | 6 Fuel pump-to-tank hose | 10 Overflow tube        | 15 Fuel tank cap |
| 2 Primary fuel filter   | 7 Injector return hose   | 11 Capscrew             | 16 Capscrew      |
| 3 Filter-to-pump hose   | 8 Fuel tank              | 12 Outlet tube          | 17 Lockwasher    |
| 4 Tank-to-filter hose   | 9 Drain cock             | 13 Fuel level indicator | 18 Nut           |
| 5 Fuel pump             |                          | 14 Fuel strainer screen |                  |

Figure 31. Fuel system, schematic diagram.

a gentle stream of fresh water until the drain water is clear.

- (4) Dry the element thoroughly with compressed air before using it.
- (5) Loosen the clamping screw (6, fig. 32) that holds the cup (7) to the base of the air cleaner; remove and clean the cup. Remove dust deposits from the air cleaner tubes with a stiff bristle brush.
- (6) After every 500 hours of operation, replace the air cleaner element with a new one. Install the cup on the air cleaner body by tightening the clamping screw (6) in the clamp (8). Position the element, inner cover, and gasket in the air cleaner body; secure with the wing bolt and gasket. Position the cover on the top of the air cleaner body and secure with the hold-down clamps (2).

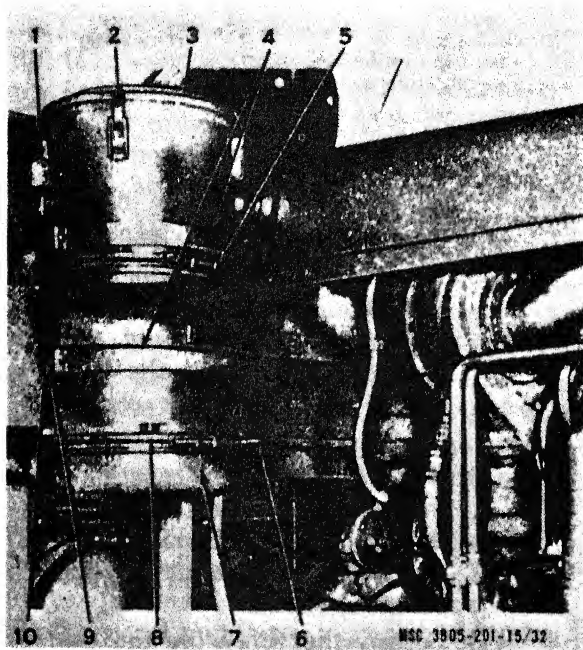
#### b. Removal.

- (1) Unscrew the restriction indicator (10, fig. 33) from the air cleaner.
- (2) Remove the cover, element, and cup assembly from the air cleaner as directed in a(1), (2), and (6) above. Loosen the screw in the hose clamp (2) that connects the elbow (3) to the air cleaner.
- (3) Remove the four capscrews, lockwashers, and nuts that hold the air cleaner mounting bands (4, fig. 32) to the loader; remove the air cleaner and mounting bands.
- (4) Loosen the screw in the remaining hose clamps (2, fig. 33). Remove and disassemble the hose clamps, hose (18), tube (1), and elbow (3).
- (5) Loosen the clamping screw of the clamp (13) and remove the clamp. Separate the upper body assembly

- (12) from the lower body assembly (14).
- (6) Do not remove the gaskets (5 and 16) unless they are damaged or deteriorated.

*c. Cleaning and Inspection.*

- (1) Thoroughly clean the air cleaner body with clean, dry compressed air. Use a bristle brush where necessary to dislodge dirt from the air passages.
- (2) Clean the air cleaner element as directed in *a*(3) and (4) above.
- (3) Clean the hose and elbow with a clean, dry cloth.
- (4) Clean all other parts with an approved cleaning solvent; dry thoroughly.
- (5) Carefully inspect the air cleaner filter element for cracks, tears, or ruptures of the paper element. Replace if damaged or if it has been in service for 500 hours.
- (6) Inspect the hose and elbow for cracks, tears, brittleness, or deterioration; replace if damaged.



- |                             |                  |
|-----------------------------|------------------|
| 1 Restriction indicator     | 5 Clamping screw |
| 2 Holddown clamp            | 6 Clamping screw |
| 3 Cover                     | 7 Cup            |
| 4 Air cleaner mounting band | 8 Clamp          |
|                             | 9 Machine screw  |
|                             | 10 Bar           |

Figure 32. Air cleaner installation.

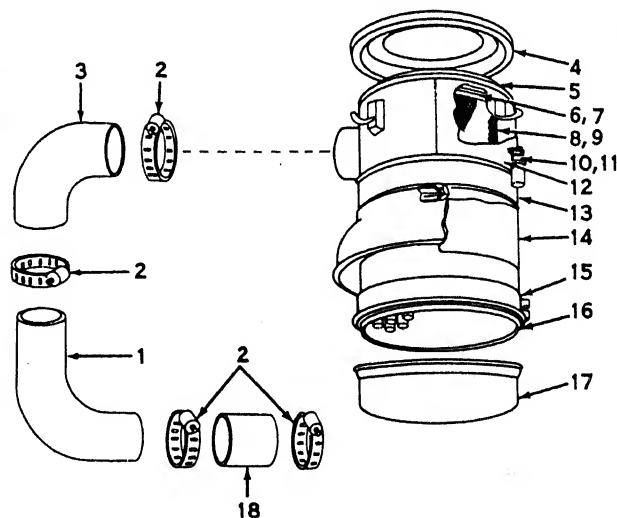
- (7) Inspect all other parts for cracks, distortion, or other damage; replace damaged parts. If the cover gasket (5) or cup gasket (16) is damaged, replace with new gaskets.

*d. Installation.* Reverse the removal procedure given in *b* above to assemble the body of the air cleaner on the loader. Assemble the remaining air cleaner parts as directed in *a*(6) above.

## 129. Fuel Filter Assembly (fig. 34)

*a. Servicing the First-Stage Filter.*

- (1) Turn the fuel tank shutoff cock to the off position.
- (2) Remove the plug (15) and drain the filter body.
- (3) Remove the crown nut (16) and washer (17) that secure the body assembly (18) to the head (3); remove the body assembly and gasket (23).
- (4) Remove the retainer (19) from the stud (21); remove the cartridge (20).
- (5) Wash the cartridge thoroughly in an



- |                      |                                  |
|----------------------|----------------------------------|
| 1 Air intake tube    | 10 Restriction indicator         |
| 2 Hose clamp         | 11 Restriction indicator fitting |
| 3 Rubber elbow       | 12 Upper body assembly           |
| 4 Cover              | 13 Clamp                         |
| 5 Cover gasket       | 14 Lower body assembly           |
| 6 Inner cover        | 15 Cup clamp                     |
| 7 Inner cover gasket | 16 Cup gasket                    |
| 8 Element            | 17 Cup                           |
| 9 Element gasket     | 18 Hose                          |

Figure 33. Air cleaner and connecting parts, exploded view.



approved solvent; drain dry.

- (6) Inspect the head-to-body gasket; replace if necessary.
- (7) Position the cartridge (20) on the stud (21); secure with the retainer (19).
- (8) Install the plug (15) on the body assembly (18).
- (9) Fill the body assembly with fuel oil; position the body assembly and gasket (23) on the head; secure with the washer (17) and crown nut (16).

*Note.* Filling the filter body assemblies with fuel oil aids starting, since the fuel pump will not have to prime the filter. The hand primer primes the fuel pump, and not the filters.

- (10) Turn the fuel tank shutoff cock to the on position.

*b. Servicing Either Second-Stage Filter.*

- (1) Turn the fuel tank shutoff cock to the off position.
- (2) Remove the plug (14) and drain the filter body.
- (3) Remove the screw (4) and gasket (5) that secure the body assembly (13) to the head (3); remove the body assembly and gasket (6).
- (4) Remove the cartridge (7) from the body assembly; discard the used cartridge.
- (5) Wash all parts thoroughly in an approved solvent; wipe dry with a clean cloth or blow dry with compressed air.
- (6) Inspect the head-to-body gasket (6); replace if necessary.
- (7) Position a new cartridge (7) in the body assembly (13).
- (8) Install the plug (14) on the bottom of the body assembly (13).
- (9) Fill the body assembly with fuel oil. Position the body assembly and gasket (6) on the head (3); secure with the screw (4) and gasket (5).

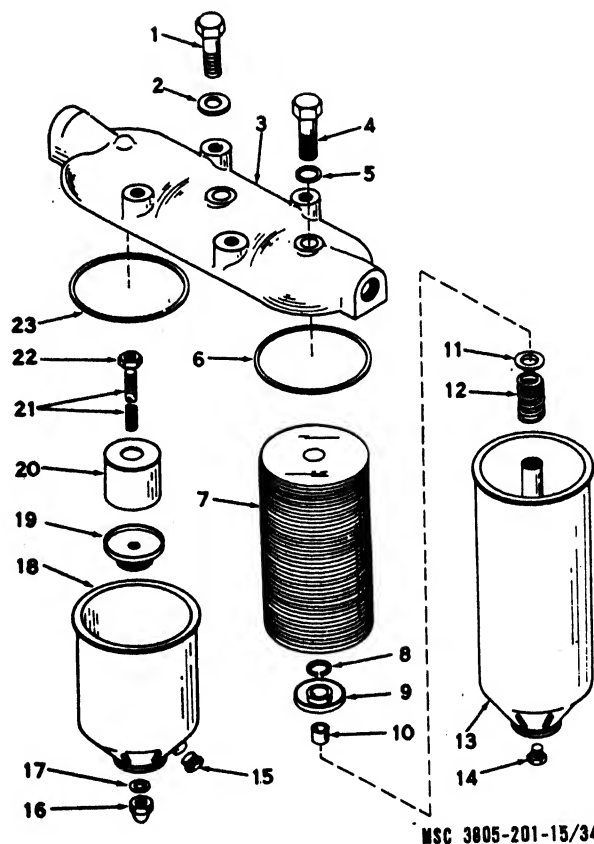
*Note.* Filling the filter body assemblies with fuel oil aids starting, since the fuel pump will not have to prime the filter. The hand primer primes the fuel pump only.

- (10) Turn the fuel tank shutoff cock to the on position.

*c. Removal and Disassembly.*

- (1) Close the fuel tank shutoff cock.
- (2) Disconnect the tank-to-filter hose and filter-to-fuel pump hose from the fittings on the fuel filter; drain the lines into a container. Remove the fittings from the filter head (3).

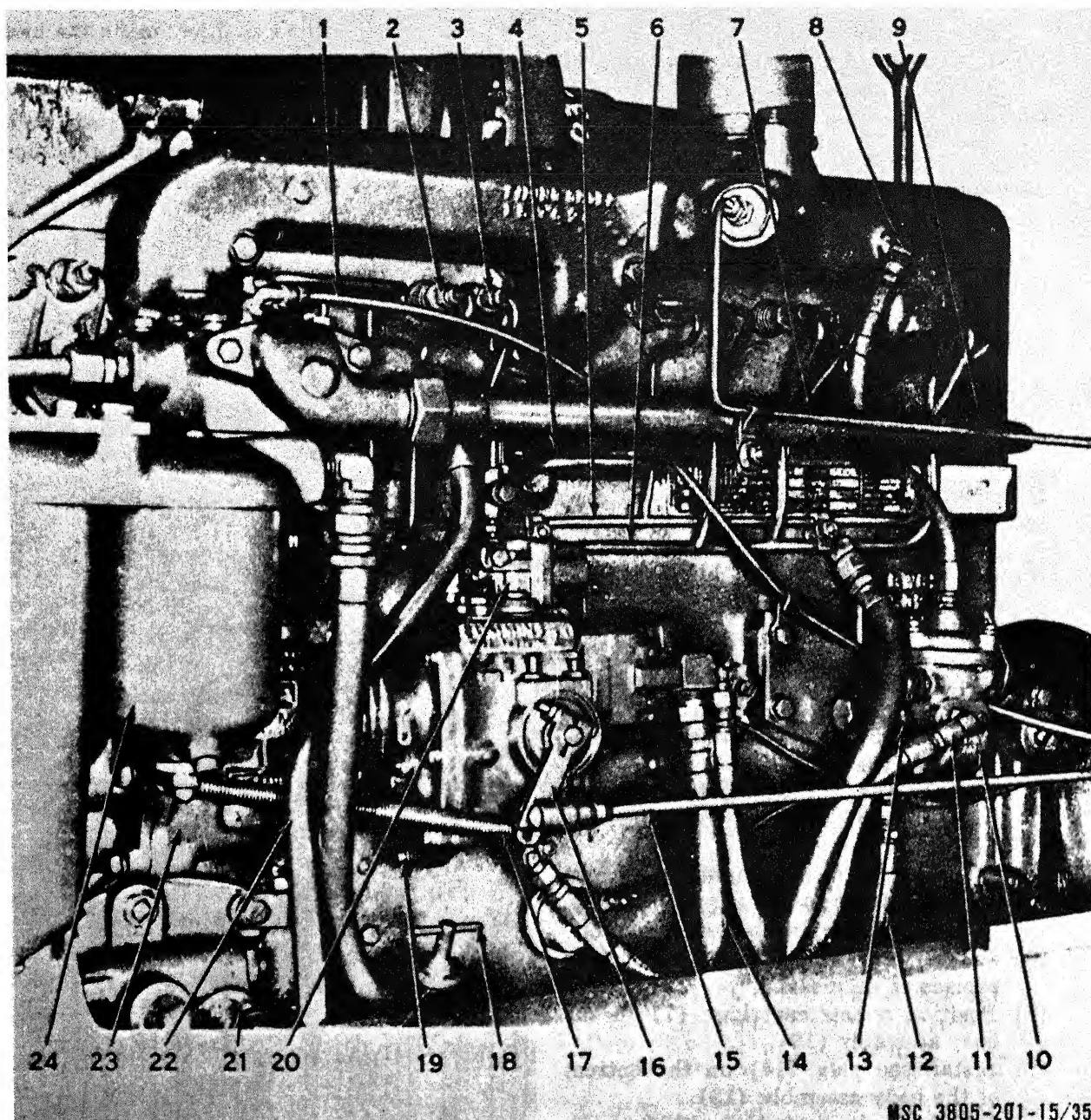
- (3) Remove the four screws (1) and lockwashers (2) that secure the fuel filter



MSC 3805-201-15/34

- |                  |                  |
|------------------|------------------|
| 1 Screw          | 13 Body assembly |
| 2 Lockwasher     | 14 Plug          |
| 3 Head           | 15 Plug          |
| 4 Screw          | 16 Crown nut     |
| 5 Gasket         | 17 Washer        |
| 6 Gasket         | 18 Body assembly |
| 7 Cartridge      | 19 Retainer      |
| 8 Retaining ring | 20 Cartridge     |
| 9 Plate          | 21 Stud          |
| 10 Grommet       | 22 Nut           |
| 11 Washer        | 23 Gasket        |
| 12 Spring        |                  |

Figure 34. Fuel filter assembly, exploded view.



MSC 3805-201-15/35

- |                                   |                            |                             |                                       |
|-----------------------------------|----------------------------|-----------------------------|---------------------------------------|
| 1 Compressor-to-air governor tube | 7 Primer discharger line   | 13 Manifold drain hose      | 19 Fuel pump                          |
| 2 Drain connection                | 8 Manifold-to-aneroid hose | 14 Filter-to-fuel pump hose | 20 Fuel shutoff valve                 |
| 3 Inlet connection                | 9 Air intake tube          | 15 Accelerator rod          | 21 Lubricating oil pressure regulator |
| 4 Fuel pump-to-manifold tube      | 10 Aneroid control         | 16 Throttle lever           | 22 Compressor outlet hose             |
| 5 Fuel drain manifold             | 11 Aneroid pressure hose   | 17 Throttle return spring   | 23 Air compressor                     |
| 6 Fuel supply manifold            | 12 Aneroid suction hose    | 18 Oil level gage           | 24 Fuel filter assembly               |

Figure 35. Fuel pump installation.

to the bracket; remove the assembled filter.

- (4) Disassemble the first-stage filter as directed in a (2) through (4) above.
- (5) Loosen the check nut (22); remove

the stud (21) from the head. Remove the check nut from the stud.

- (6) Disassemble each second-stage filter as directed in b (2) through (4) above.
- (7) Remove the retaining ring (8) that



secures the plate (9) in each body assembly (13); remove the plate, grommets (10), washers (11), and springs (12).

*d. Cleaning and Inspection.*

- (1) Discard the used filter cartridges and head-to-body gaskets.
- (2) Clean all parts with an approved solvent; dry with compressed air.
- (3) Inspect all parts for worn threads, cracks, or other damage, replace damaged parts.
- (4) Inspect the springs for loss of tension; replace if weak or deformed.

*e. Reassembly and Installation.*

- (1) Position the grommet (10), spring (12), washer (11), and plate (9) in the body assembly (13) of each second-stage filter; secure with a retaining ring (8).
- (2) Assemble and install the second-stage filters on the filter head as directed in b(7) through (9) above.
- (3) Position the check nut (22) on the stud (21); install the stud in the head (3). Secure by tightening the check nut.
- (4) Assemble and install the first-stage filter on the filter head as directed in a(7) through (9) above.
- (5) Position the assembled filter on the bracket so that the first-stage filter is toward the front of the loader; secure with four screws (1) and lockwashers (2).
- (6) Install two fittings on the fuel filter; connect the tank-to-filter hose and the filter-to-fuel pump hose to the fittings.
- (7) Open the fuel tank shutoff cock.

### 130. Fuel Pump

*a. Check and Adjustments.*

*(1) Fuel line restriction.*

- (a) Using the necessary fittings and adapter, connect a restriction indicator into the fuel supply line at the fuel pump (19, fig. 35). Operate the engine until the oil temperature reaches 180° F. to 200° F.
- (b) If the restriction indicator reads as

much as 8 inches of mercury, service the fuel filter as directed in paragraph 129.

- (c) If the restriction indicator does not drop after the filter has been serviced, remove and flush out the fuel lines.
- (d) If the restriction indicator registers as much as 10 to 11 inches, remove, clean, and inspect all fuel system components.

*Note.* The above checks must be performed on a hot engine. Operate the engine a minimum of 5 minutes between checks to expel air pockets from the fuel lines.

*(2) Idle adjustment (fig. 36).*

- (a) Remove the idle adjusting plug from the spring pack cover.
- (b) Insert a screwdriver and turn the adjusting screw in to increase the idle speed, or out to decrease the idle speed.

*Note.* Idle speed should be set at 30 to 40 rpm lower than desired if the adjustment is made with the engine running. Air collecting in the spring pack housing results in a speed change when the housing fills with fuel.

*b. Servicing Fuel Pump Filter (fig. 37).*

- (1) Remove the filter cap (1) and seal (2) from the top of the fuel pump.

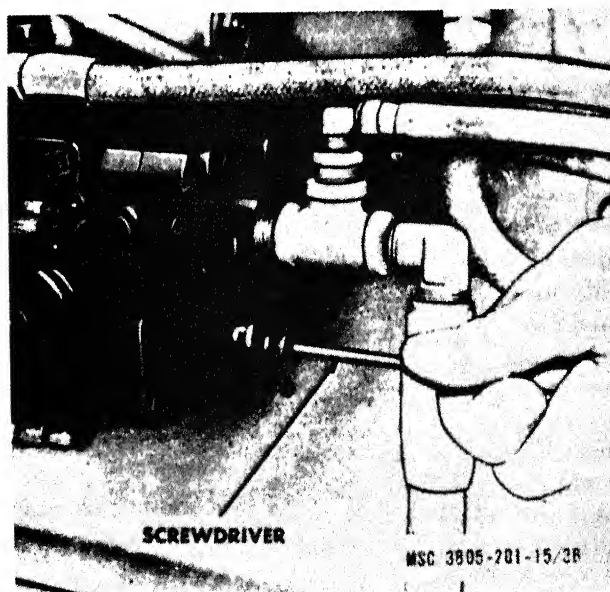
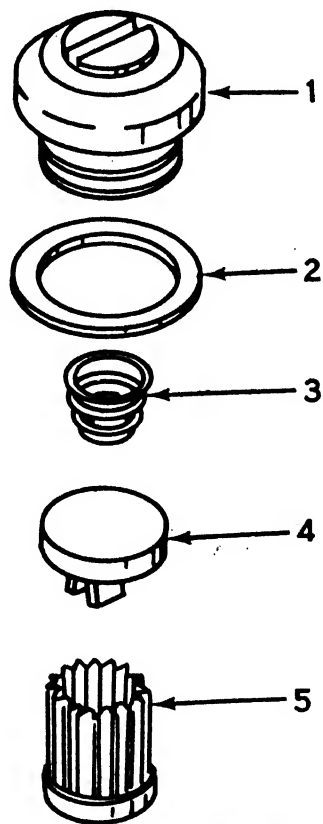


Figure 36. Adjusting idle speed.



NSC 3005-201-15/37

- |          |                       |
|----------|-----------------------|
| 1 Cap    | 4 Retainer and magnet |
| 2 Seal   | 5 Filter screen       |
| 3 Spring |                       |

Figure 37. Fuel pump screen, exploded view.

- (2) Lift out the spring (3) and assembled filter screen and retainers.
- (3) Separate the screen (5) from the retainer and magnet (4) for easy cleaning. Flush the screen in an approved solvent until there is no dirt present; blow dry with compressed air.
- (4) Position the retainer and magnet (4) on the filter screen (5). Install the assembled filter screen and retainer so that the retainer with the hole is downward; position the spring (3) over the retainer and magnet with the small end down.
- (5) Place the seal (2) on the cap (1); install the cap on the fuel pump and tighten to 20 to 25 foot-pounds torque with a torque wrench. Do not over-tighten.

c. Fuel Pump Removal (fig. 35).

- (1) Disconnect the aneroid pressure hose

- (11) and suction hose (12) from the fuel pump.
- (2) Disconnect the filter-to-fuel pump hose (14) from the fuel pump.
- (3) Remove the nut and lockwasher that secure the ball joint on the accelerator rod (15) to the fuel pump throttle lever. Disconnect the spring (17) from the throttle control lever and bracket.
- (4) Disconnect the fuel pump-to-manifold tube (4) from the fuel shutoff valve (20).
- (5) Disconnect the leads from the fuel shutoff valve.
- (6) Remove the four capscrews, lockwashers, and flat washers that secure the fuel pump to the air compressor (23); remove the fuel pump, gasket, and the rubber coupling spider (fig. 38).
- (7) Plug all openings to the fuel pump to prevent the entrance of dirt or foreign matter.

d. Cleaning and Inspection.

- (1) Clean all dirt and grease from the exterior of the fuel pump with cleaning solvent.
- (2) Replace all cracked or damaged fittings.
- (3) Repair or replace a defective fuel pump.
- (4) Inspect the drive coupling spider; replace if deteriorated or excessively worn.

e. Installation.

- (1) Position the drive coupling spider on the air compressor coupling half as shown in figure 38.
- (2) Aline the fuel pump coupling half with the open spaces of the coupling spider; position the gasket on the mounting flange.
- (3) Position the fuel pump on the air compressor (23, fig. 35); secure with four capscrews, flat washers, and lockwashers.
- (4) Connect the fuel pump-to-manifold tube (4) to the fuel shutoff valve (20).
- (5) Connect the leads to the fuel shutoff valve.
- (6) Position the ball joint of the accelerator rod (15) on the fuel pump throttle

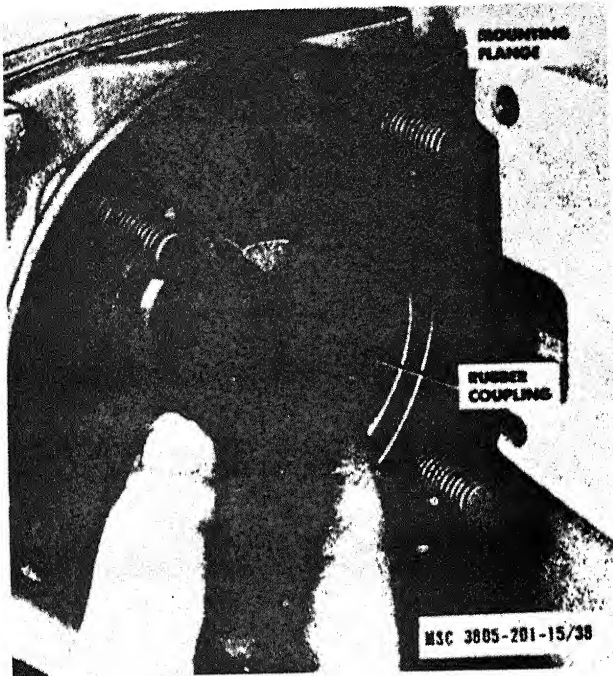


Figure 38. Fuel pump drive coupling spider.

control lever, secure with a nut and lockwasher. Connect the spring (17) to the bracket on the air compressor and to the throttle control lever.

- (7) Connect the aneroid pressure hose (11) and suction hose (12) to the fuel pump.
- (8) Squirt a few drops of clean lubricating oil into the fuel pump inlet to prime the fuel pump; connect the filter-to-fuel pump hose (14).

### 131. Fuel Tank and Lines

**a. Filling.** Fill the fuel tank with clean fuel, carefully handled to prevent the entry of dirt, moisture, and other foreign matter into the fuel system. Use a good grade of fuel with a minimum cetane rating of 40.

#### **b. Servicing Fuel Strainer.**

- (1) Remove the fuel filler cap (1, fig. 14) and lift upward on the fuel strainer screen (4) while turning it to release it from the fuel tank. Remove the assembled cap, chain (5), and strainer. Disassemble the parts.
- (2) Thoroughly wash the fuel strainer screen with an approved cleaning solvent. If necessary, apply com-

pressed air in a direction opposite the fuel flow to dislodge particles from the screen. Dry thoroughly.

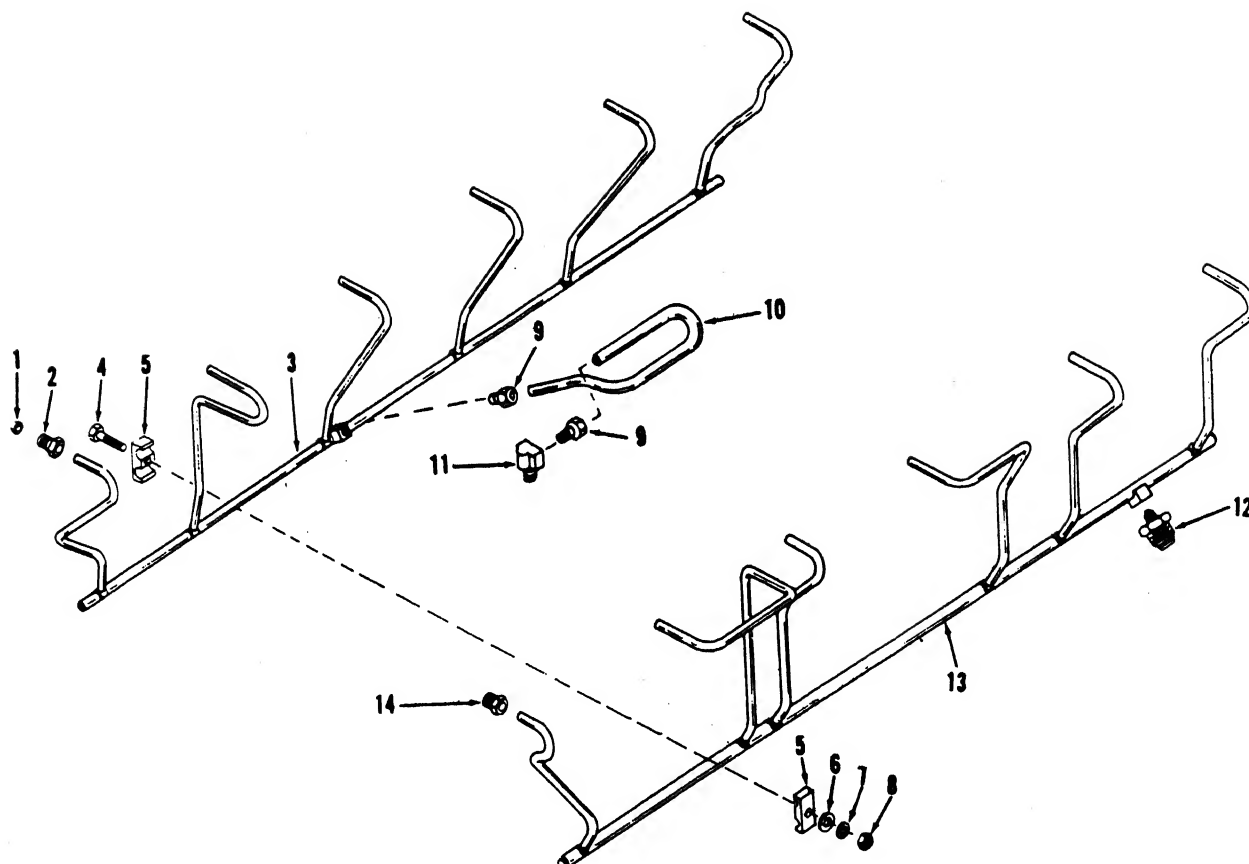
- (3) Assemble the fuel strainer screen, chain, and fuel tank cap. Install the assembled parts on the tank.

#### **c. Disassembly (fig. 31).**

- (1) To drain the fuel tank; place a clean container under the drain cock (9) of the fuel tank (8). Drain the fuel from the tank.
- (2) Remove the engine hood side panels from the loader. Remove the counterweight from the loader.
- (3) Disconnect the tank-to-filter hose (4), fuel pump-to-tank hose (6), and injector return hose (7) from the outlet tube (12) of the fuel tank.
- (4) Support the fuel tank with suitable blocking or a jack. Remove the six capscrews (16), lockwashers (17), and nuts (18) that hold the fuel tank to the frame; remove the fuel tank.
- (5) Remove the fuel strainer as directed in *b* above.
- (6) Remove the drain cock (9) from the fuel tank. Remove the overflow tube (10) from the outlet tube of the fuel tank. Remove the fuel level indicator (13) from the fuel tank.
- (7) Remove the four capscrews (11) and lockwashers that secure the outlet tube (12) to the fuel tank; remove the outlet tube and gasket.
- (8) Remove the fuel lines as indicated in figure 31.

#### **d. Cleaning and Inspection.**

- (1) Plug the fuel tank ports and pour an approved cleaning solvent into the fuel tank. Rock the tank back and forth to clean it. Drain the tank. Repeat this operation until the solvent is clean when it is drained from the tank. Steam-clean the exterior of the fuel tank.
- (2) Blow through all fuel lines with compressed air to make sure they are open. Clean the hoses with a dry cloth. Clean the tubes with a cloth dampened with solvent.
- (3) Clean all other parts with an approved cleaning solvent; dry thoroughly.



MSC 3805-201-15/39

1 Ferrule  
2 Tube nut  
3 Supply manifold  
4 Screw

5 Clip  
6 Flatwasher  
7 Lockwasher  
8 Nut

9 Tube nut  
10 Tube  
11 Elbow

12 Drain connection  
13 Drain manifold  
14 Tube nut

Figure 39. Supply and drain manifolds, exploded view.

- (4) Carefully check the fuel tank for cracks, leaks, bad dents that could develop leaks, and broken weldments. Replace if damaged.
- (5) Inspect the hoses for clogging, damaged fittings, deteriorated covering, collapsed walls, and bad kinks; replace if damaged. Inspect the fuel tubes for kinks and restrictions. Check the fittings for worn threads, cracks, or damage; repair or replace damaged tubes.
- (6) Inspect the outlet tube for cracks, worn or damaged threads, and distortion; replace if damaged.
- (7) Inspect the fuel drain cock for leaking, cracks, and sticking operation. Replace if damaged.

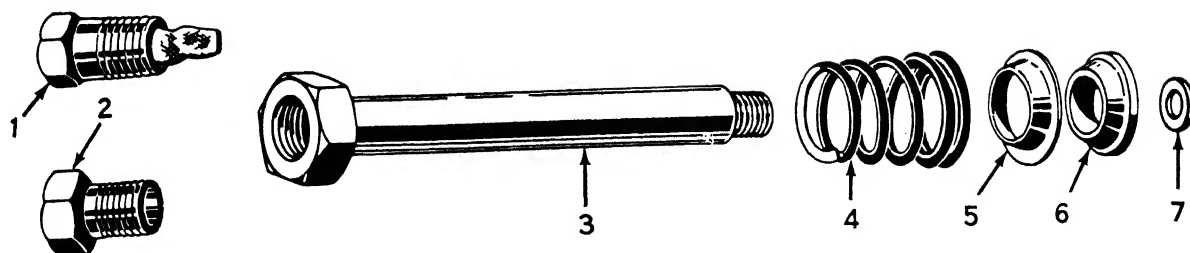
*e. Reassembly.* Reassemble the fuel tank,

lines, and fittings by reversing the procedure described in *c* above.

### 132. Fuel Supply and Drain Manifolds

#### *a. Removal.*

- (1) Disconnect the fuel pump-to-manifold tube nuts (9, fig. 39) from the shut-off valve and supply manifold (3); remove the tube.
- (2) Disconnect the injector return hose (7, fig. 31) from the drain connection (12, fig. 39).
- (3) Disconnect the manifold tube nuts (2 and 14) that secure the supply manifold (3) and drain manifold (13) to the injector inlet and drain connections.
- (4) Remove the screws (4), nuts (8),



MSC 3805-201-15/40

1 Inlet connection  
2 Drain connection

3 Connection body  
4 Spring

5 Gasket retainer  
6 Gasket

7 Gasket

Figure 40. Fuel connections, exploded view.

lockwashers (7), and flat washers (6) that secure the clips (5) to the manifolds; remove the clips, supply manifold, and drain manifold.

**b. Cleaning and Inspection.**

- (1) Clean the exterior of all lines and fittings with a cloth dampened in an approved solvent.
- (2) Inspect the connections and nuts for cracks or stripped threads.
- (3) Flush out the lines and blow dry with compressed air.
- (4) Inspect the manifolds for cracks, kinks, or other damage.
- (5) Replace all unserviceable parts.

**c. Installation.** Reassemble the fuel supply

and drain manifolds by reversing the removal procedure described in *a* above.

### 133. Injector Fuel Connections

**a. Injector Inlet Connection Service.**

- (1) Disconnect the supply manifold (3, fig. 39) from each of the inlet connections (1, fig. 40). These are the connections on the right side of each cylinder.
- (2) Remove the inlet connection from the body as shown in figure 41; remove the screen from the inlet connection.
- (3) Wash the inlet connection screen in a suitable solvent; blow dry with compressed air.
- (4) Position the screen in the inlet connection; screw the inlet connection into the inlet connection body.
- (5) Clean the other inlet connections in the same manner.
- (6) Connect the supply manifold to the inlet connection; tighten securely to prevent fuel leakage.

**b. Removal.**

- (1) Disconnect the manifold tube nuts (2 and 14, fig. 39) from the injector inlet and drain connections.
- (2) Disconnect the inlet connections (1, fig. 40) and drain connections (2) from the bodies (3).
- (3) Remove the connection bodies from the injectors. Remove the gaskets (6 and 7), gasket retainer (5), and spring (4) from each connection body.



Figure 41. Removing inlet connections from body.

*c. Cleaning and Inspection.*

- (1) Wash the parts with a suitable cleaning solvent; dry with compressed air.
- (2) Examine the connections and bodies for cracks, stripped threads, or other damage; replace if defective.
- (3) Replace the springs if weak or broken; replace the gaskets if worn or damaged.

*d. Installation.* Install the injector fuel connections by reversing the removal sequence given in *b* above.

### 134. Injectors

*a. General.* The injector is a simple mechanical unit which receives fuel under pressure from the fuel pump and injects it through the fine spray holes of the injector cup, into the combustion chamber. Fuel circulates through the injector at all times except during a short

period following injection. From the inlet connection, fuel flows down the inlet passage of the injector, around the injector plunger, between the body end and the cup, up the drain passage to the drain connections and manifold, and back to the fuel tank. The amount of fuel entering the injector cup is controlled by the fuel pressure against the metering orifice. The injector cross section is shown in figure 42, and the fuel flow is indicated by the arrows in figure 43.

*b. Cleaning.* After each 480 hours of engine operation, carbon accumulation should be removed from the injector metering orifices by reverse flushing. Perform this operation on a warm engine as follows:

- (1) Remove the cylinder head cover as directed in paragraph 164a.
- (2) Loosen the locknut and loosen half of the injector adjusting screws one turn from the bottom or  $1\frac{1}{4}$  turns from the set position; secure the locknut.
- (3) Install the cylinder head cover as directed in paragraph 164c.
- (4) Start the engine and accelerate with maximum throttle from high idle 10 to 15 times.
- (5) Readjust the injectors as directed in *c* below and perform the same procedure for the remaining half of the injectors.

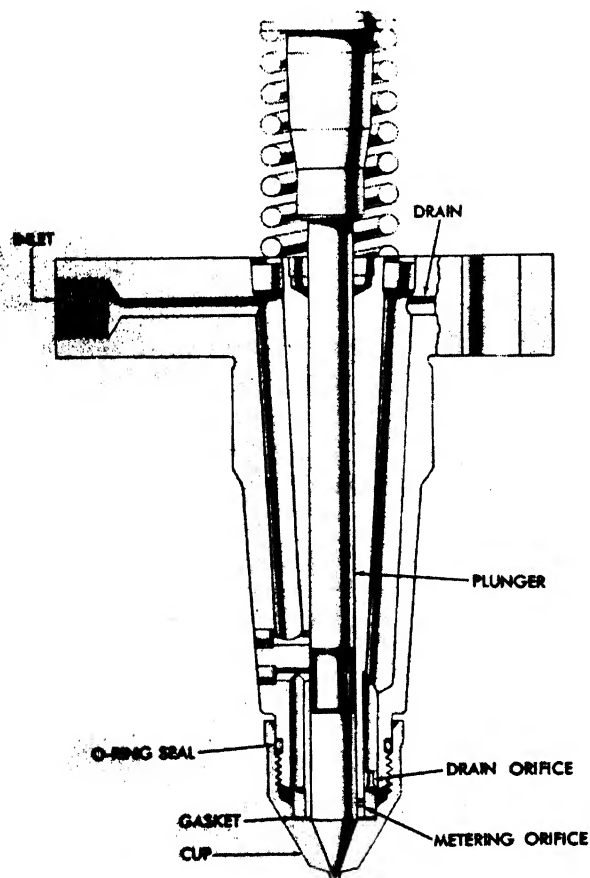
*Note.* When the injector is set with the adjusting screw backed off, the metering orifice will not be closed during injection. High injection pressures will cause some of the fuel to backflow through the orifice and remove the carbon deposits. Starting will be difficult, and the engine will smoke badly and act sluggish during this operation.

- (6) If this method fails to clean the injectors properly, refer to the next higher echelon of maintenance.

*c. Adjustment.*

*Note.* Injectors should always be adjusted before valves.

- (1) Crank the engine until the "1-6VS" valve set mark on the accessory drive pulley (fig. 44) is in line with the arrow on the gear case cover. This is the correct position for adjustment of the No. 1 cylinder injector and valves. The injector and valve can be adjusted for only one cylinder at a time in order



MSC 3805-281-15/42

Figure 42. Injector cross section.

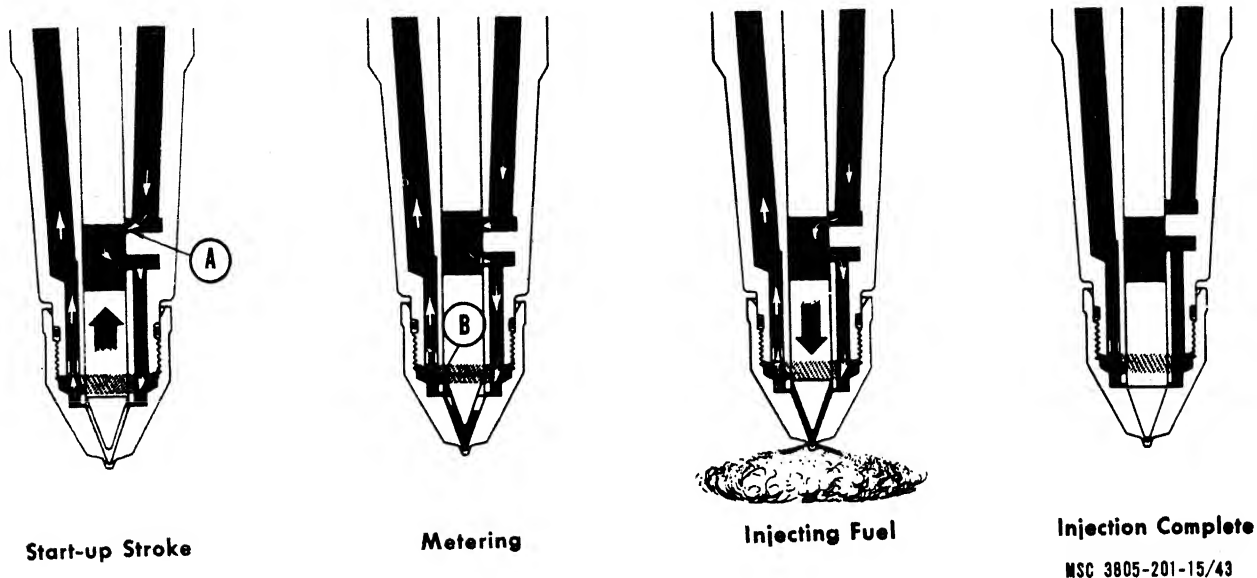


Figure 43. Fuel injection cycle.

of firing. This position is also used for the No. 6 cylinder in correct order.

- (2) Remove the cylinder head cover as directed in paragraph 164a.
- (3) Loosen the locknut and turn the adjusting screw on the rocker lever down until the injector plunger contacts the cup; turn the screw down an additional 15° to squeeze oil from the cup.
- (4) Loosen the adjusting screw one turn.

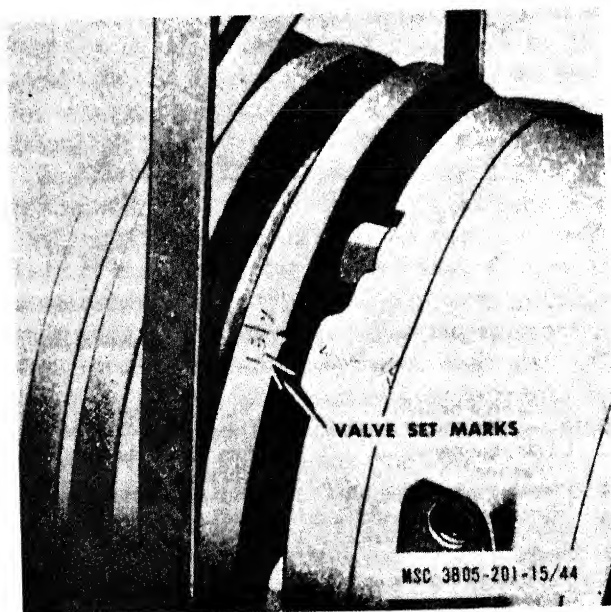


Figure 44. Valve set marks.

- (5) Use a torque wrench calibrated in inch-pounds and a screwdriver adapter as shown in figure 45 to tighten the adjusting screw to 48 inch-pounds (cold setting at 70° F.).
- (6) Secure with the locknut; tighten to 70 to 80 foot-pounds.
- (7) Adjust the valves for the No. 1 cylinder as directed in paragraph 165.
- (8) Turn the engine until the valve set mark for the next cylinder is in line with the arrow on the gear case cover. The firing order for this engine is 1-5-3-6-2-4. Adjust the injectors for cylinder No. 5 and then the valves for that cylinder. Continue in this manner, making adjustments until all injectors and valves have been adjusted at the cold settings.
- (9) Start and warm up the engine to 140° F.; shut the engine down and reset the injectors to 60 inch-pounds.
- (10) Install the cylinder head cover as directed in paragraph 164c.

### 135. Primer Discharger (fig. 46)

#### a. Removal and Disassembly.

- (1) Open the door of the tool compartment at the right side of the operator's seat.
- (2) Disconnect the tubing (16) from the





Figure 45. Adjusting injector plungers.

elbow (17) on the discharger shell assembly (12).

- (3) Remove the two nuts (20) and lockwashers (19) that secure the primer discharger to the inside of the tool compartment; remove the primer discharger, U-bolt (11), and clamp (18).
- (4) Turn the cartridge holder (1) from the discharger cap body (5).
- (5) Remove the assembled discharger cap body (5), piercing pin (4), and discharger cap gasket (6).
- (6) Turn the retaining ring (2) out of the discharger cap body (5); remove the cartridge neck washer (3) and piercing pin assembly (4) from the body.
- (7) Remove the elbow (17) and valve seat and adapter (15) from the shell assembly (12).
- (8) Remove the cotter pin (9) that secures the valve assembly (14) to the valve trigger (10); carefully remove the valve assembly and valve trigger.

**Warning:** The valve assembly (14) is strongly spring loaded. Take care to prevent the valve from striking surrounding personnel as the cotter pin (9) is removed.

- (9) Turn the stuffing box nut (8) out of the shell assembly. Remove the packing (7).

*b. Cleaning and Inspection.*

- (1) Clean all metallic parts with an ap-

proved cleaning solvent; dry thoroughly.

- (2) Wipe all nonmetallic parts with a clean cloth.
- (3) Inspect the piercing pin assembly for clogging and for a broken tip or distorted spring. Open a clogged passage with a fine wire. Replace the assembly if the tip is broken or if the spring is distorted.
- (4) Check the seating surface of the valve assembly for distortion, deterioration

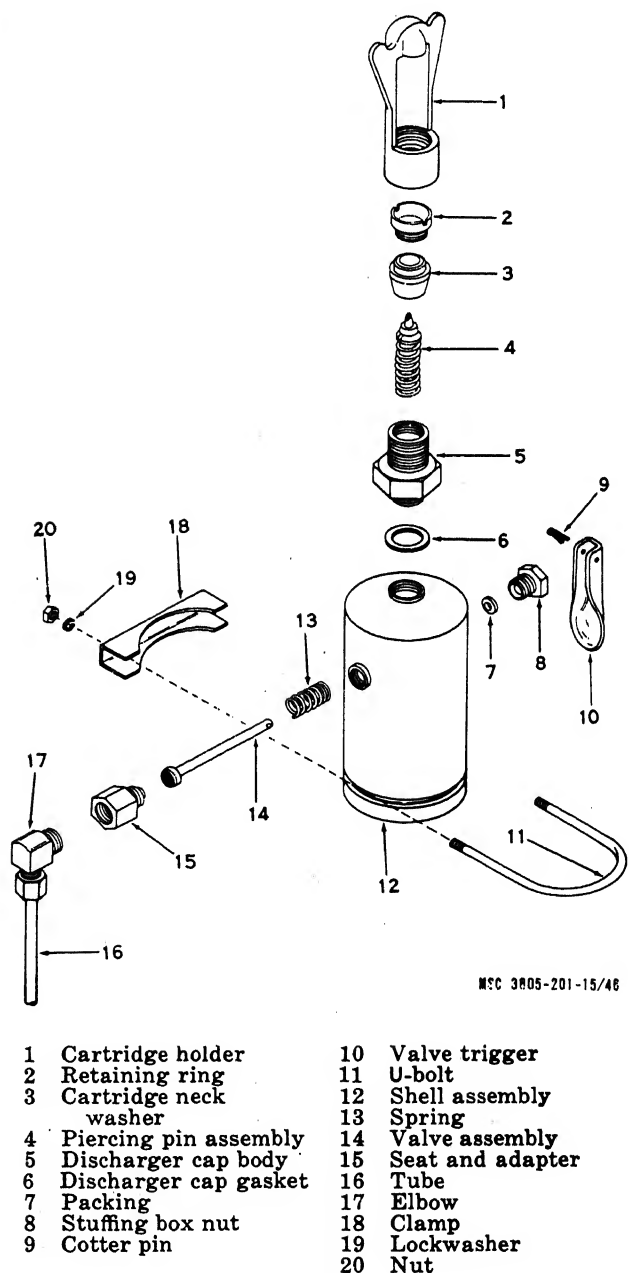


Figure 46. Primer discharger, exploded view.



or wear. Some indentation from the valve seat is normal and does not harm the effectiveness of the valve. Replace a damaged valve assembly.

- (5) Inspect the shell assembly for cracks, leaks, or distortion; replace a damaged shell.
- (6) Inspect all other parts for cracks, dis-

tortion, worn or damaged threads, or other damage that could prevent proper operation of the part.

*c. Reassembly and Installation.* Reassemble and install the primer discharger by reversing the removal and disassembly procedure given in subparagraph *a* above.

## Section VI. ELECTRICAL SYSTEM

### 136. Description (fig. 4)

*a. Batteries.* The loader uses four dry-charge, 12-volt, lead-acid type storage batteries (7) to provide the electrical current necessary to turn over the starting motor. The batteries are series-parallel connected to provide a 24-volt output to operate the starting motor and the other electrical equipment.

*b. Generator.* The generator (35) is driven by a V-belt, and converts the mechanical energy it receives from the engine into electric current. The current is used to operate the electrical equipment of the loader while the engine is operating and to restore the batteries to full charge after they are partially discharged due to starting or any other drain that occurs when discharge of the electrical system exceeds the amount of charge.

*c. Voltage Regulator.* The voltage regulator (5) is an electrically operated relay-type unit that controls the generator output by controlling the current flow to the field coils of the generator. It maintains the batteries at near full charge, but prevents the generator from damaging the batteries by excessive charge.

*d. Starting Motor.* The starting motor receives electrical power from the battery and converts it into mechanical energy necessary to turn over the engine for starting. It uses an overrunning clutch type of engagement with the ring gear on the flywheel. The engagement is done by a solenoid-operated lever that pivots to mesh the parts. After engagement is made, the switch portion of the solenoid closes the electrical circuit to cause motor rotation.

*e. Lighting System.* The lighting system provides lights necessary for normal operation as well as for blackout operation. Main control of the lighting system is provided by the light control switch (24) which incorporates a locking

feature to prevent accidental operation of the regular lighting system during blackout conditions. The stoplights (2 and 36) are energized through a stoplight switch (17) which is mounted on the brake system power cluster and which closes when the brake is operated. The rear floodlight switch (25) and front floodlight switch (26) are provided for normal lamp operation.

*f. Horn.* The circuit to the horn is closed when the horn button (32) is depressed. When the circuit is closed, it opens an air valve on the air horn (30), and a blast of air from the air system causes the horn to sound.

*g. Low Air Pressure Buzzer.* The low air pressure buzzer (31) sounds when the ignition is turned on and there is less than 54 psi air pressure available in the reservoir to operate the air-over-hydraulic brake system. The circuit to the buzzer is actuated by the low air pressure indicator (19) which is operated by air pressure from the brake system.

*h. Circuit Breakers.* Three circuit breakers (18) are used to protect the electrical circuits from overload. One circuit breaker protects all the circuits that are connected through the main ignition switch (28). The second protects the circuit to the electrical outlet (29). The third protects the circuit to the horn (30).

*i. Fuel Pump Shutoff Solenoid.* The fuel pump shutoff solenoid (34) is incorporated into the fuel pump and is under control of the ignition switch (28). As the ignition switch is turned on, the solenoid of the shutoff solenoid is energized to allow fuel to flow from the pump to the injectors. Maintenance of the shutoff solenoid is covered as part of the fuel pump.

### 137. Batteries

*a. Testing.* Release the two latches and open the battery box door. Fill the batteries with dis-

tilled water until the electrolyte is to the bottom of the filler hole.

*Note.* Do not take battery test readings directly after adding water. Allow the engine to run for an hour before taking a hydrometer reading. With a standard hydrometer, test each battery cell. The specific gravity reading will vary with the temperature. Correct the reading to compensate for the temperature variation.

*b. Removal.*

- (1) Open the side door and the top of the battery box.
- (2) Disconnect the battery cables (2, fig. 47) that connect the battery terminals to the terminal block (21). Remove the battery jumper cables (1).
- (3) Remove the eight wingnuts (4) that secure the two battery holddown bars (3) and battery holddown hooks (6) to the holddown rods (9); remove the bars and hooks. Remove the holddown rods.
- (4) Lift the four batteries (7) from the battery box (16).

*c. Cleaning and Inspection.*

- (1) Wipe all dirt and corrosion from the batteries, cables, and battery box. Flush the tops of the batteries with a mild solution of bicarbonate of soda.
- (2) Clean the cable terminals and battery posts with sandpaper; coat lightly with grease.
- (3) Inspect the cables for frayed or oil-soaked insulation and damaged terminals.
- (4) Inspect the batteries for cracks, damage, and specific gravity reading.
- (5) Replace all unserviceable parts.

*d. Installation.* Install the batteries by reversing the removal procedure described in subparagraph *b* above. Connect the batteries as shown in the wiring diagram in figure 4.

### 138. Circuit Breakers (fig. 4)

*a. Removal.*

- (1) Disconnect the electrical leads to the three circuit breakers (18) located on the front panel of the operator's compartment. Tag the leads to facilitate reassembly.
- (2) Remove the two machine screws that secure each of the circuit breakers to the panel; remove the circuit breakers.

*b. Cleaning and Inspection.*

- (1) Wipe the exterior of the circuit breakers with a cloth dampened with an approved cleaning solvent; dry thoroughly.
- (2) Inspect the circuit breakers for cracks, damaged terminals, signs of overheating, or other damage. Use an ohmmeter to check the circuit breakers for electrical continuity. If the circuit breakers lack continuity or are otherwise damaged, replace them.

*c. Installation.*

- (1) Position the circuit breakers (18) on the front panel of the operator's compartment; secure each with two machine screws.
- (2) Connect the electrical leads to the circuit breakers as shown in figure 4.

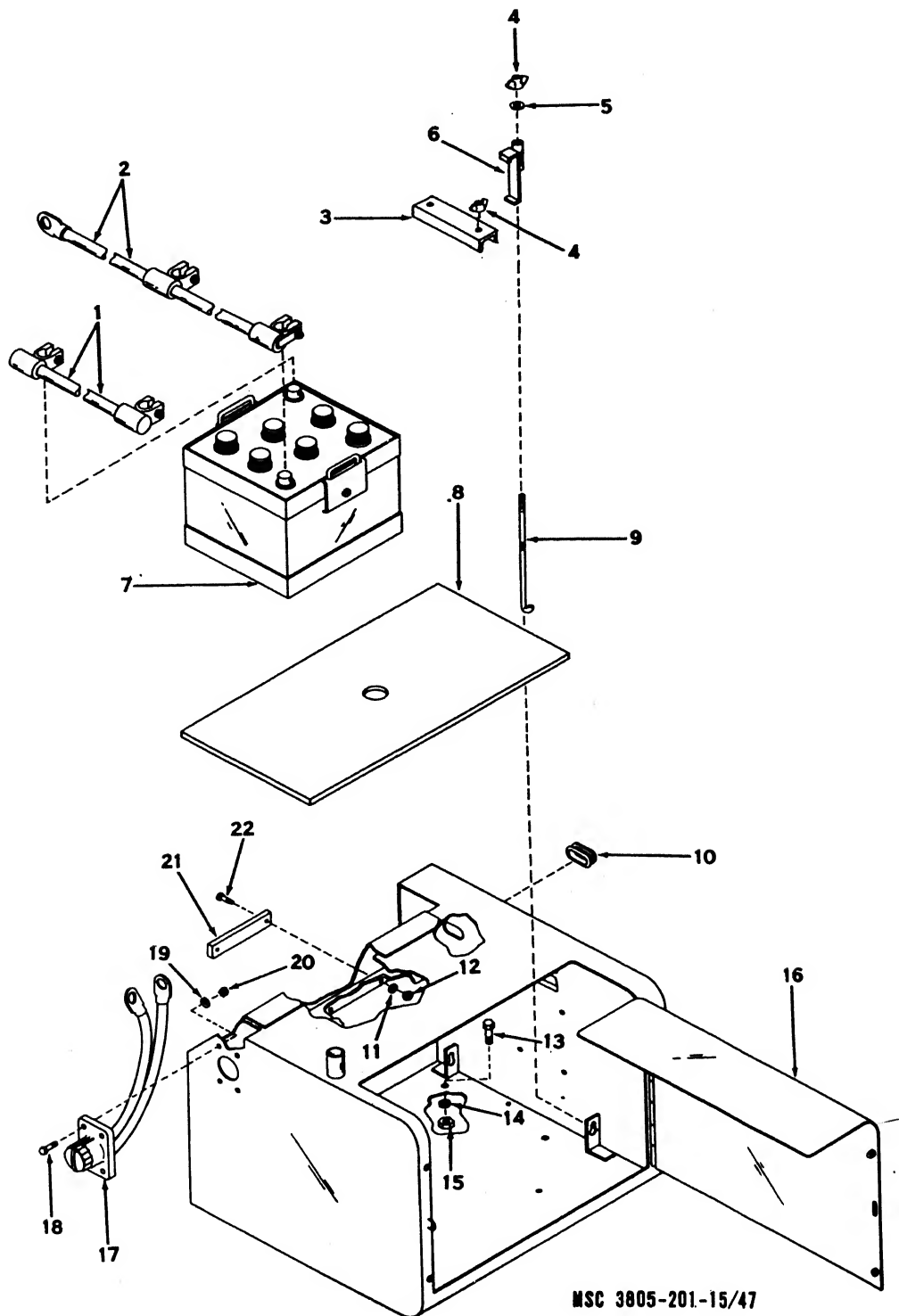
### 139. Generator

*a. Inspection and Service.*

- (1) Loosen the screw (2, fig. 48) on the cover band (1) and slip the cover band forward to expose the inspection opening.
- (2) Inspect the commutator and brushes. The commutator should have a polished surface. If the surface is dirty, run a strip of No. 00 sandpaper under the brushes as shown in figure 49. Hold it against the commutator while turning the engine over a few turns with the starter. Do not crank the engine for periods longer than 15 seconds. Allow time between cranking for the starter windings to cool.

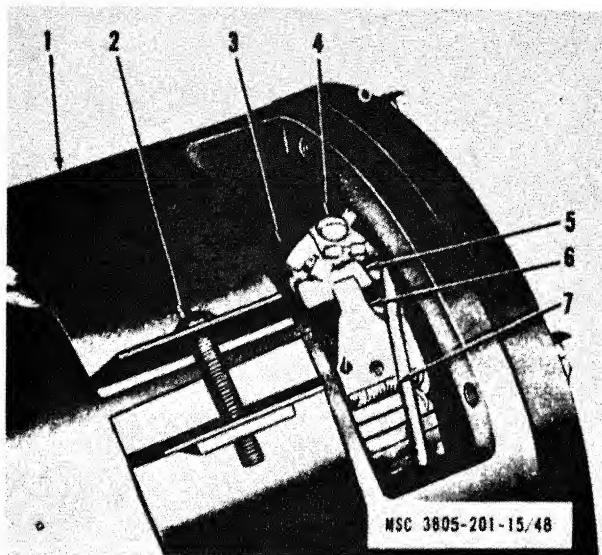
**Caution:** Do not use emery cloth to clean the commutator or to seat the brushes. Abrasive material will cause short circuits and seriously damage the generator.

- (3) If the mica between the commutator segments is high or the commutator is worn or pitted, overhaul or replace the generator. Refer to chapter 4 for overhaul instructions.
- (4) See that the brushes (5, fig. 48) move freely in their holders. Replace oil-soaked brushes or brushes that are worn to half their original length.
- (5) Check the tension of the brush springs (7) with a spring scale. Insert a piece



- |  |                         |                |                   |
|--|-------------------------|----------------|-------------------|
| 1 Battery jumper cable                       | 6 Battery holddown hook | 11 Lockwasher  | 17 Receptacle     |
| 2 Battery-to-terminal block cable (negative) | 7 Battery support       | 12 Nut         | 18 Capscrew       |
| 3 Battery holddown bar                       | 8 Battery support       | 13 Capscrew    | 19 Lockwasher     |
| 4 Wing nut                                   | 9 Holddown rod          | 14 Lockwasher  | 20 Nut            |
| 5 Flat washer                                | 10 Grommet              | 15 Nut         | 21 Terminal block |
|  |                         | 16 Battery box | 22 Capscrew       |

Figure 47. Battery and battery box, exploded view.



- |   |            |   |              |
|---|------------|---|--------------|
| 1 | Cover band | 5 | Brush        |
| 2 | Screw      | 6 | Brush arm    |
| 3 | Lead       | 7 | Brush spring |
| 4 | Screw      |   |              |

Figure 48. Generator brush replacement.

of paper between the brush (5) and the commutator. Hook a spring scale to the brush arm (6) and pull on a line parallel with the side of the brush. Note the tension on the scale when the brush leaves the commutator, releasing the paper. The minimum tension should be 28 ounces. If the minimum spring tension is not correct, overhaul the generator as directed in chapter 4 to the extent of replacing the springs.

- (6) Slip the cover band (1) over the inspection opening of the generator and secure it with the cover band screw (2).

**b. Brush Replacement (fig. 48).**

- (1) Loosen the screw (2) securing the cover band (1); slip the band forward.
- (2) Remove the screw (4) and lockwasher that secure the brush leads (3) to the brush holder; remove the brush leads.
- (3) Lift the brush arm (6) that retains the brush (5) in the holder; remove the brush.
- (4) Lift the brush arm, insert the new brush, and release the arm to retain it.
- (5) Position the brush lead on the brush holder and secure it with the screw and lockwasher.

- (6) Position the cover band over the generator inspection opening; secure with the screw.

**c. Drive Belt Adjustment and Replacement.**

**(1) Adjustment.**

- (a) Loosen the cap screw (4, fig. 50), lockwasher, and flat washer that secure the generator (7) to the adjusting link (3). Loosen the generator mounting cap screws (1). Pry between the engine and generator to adjust the belt tension as indicated in figure 51.

- (b) Tighten the cap screw, lockwasher, and flat washer against the adjusting link. Tighten the generator mounting cap screws.

**(2) Replacement.**

- (a) Loosen the cap screw (4, fig. 50), lockwasher, and flat washer that secure the generator to the adjusting link (3). Loosen the two generator mounting cap screws (1). Swing the generator away from the engine to release the tension on the drive belt (10).

- (b) Loosen the fan adjusting screw (12) sufficiently to allow the fan drive belts (13) to be removed from the accessory drive pulley; remove



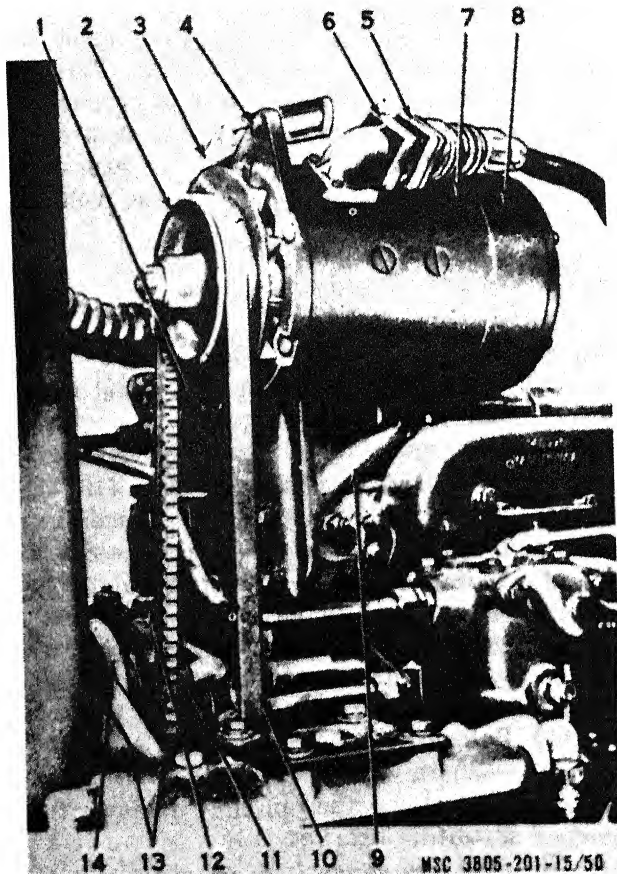
Figure 49. Polishing generator commutator.

the belts from the accessory drive pulley.

- (c) Remove the generator drive belt (10) from the generator pulley (2) and accessory drive pulley.
- (d) Position a new drive belt over the generator pulley and accessory drive pulley; adjust as indicated in figure 51.
- (e) Position the fan drive belts over the fan and accessory drive pulleys; adjust as indicated in figure 51.

*d. Removal (fig. 50).*

- (1) Remove the generator drive belt as directed in c(2) above.
- (2) Disconnect the shielded cable (5) from



- |                  |                          |
|------------------|--------------------------|
| 1 Capscrew       | 9 Mounting bracket       |
| 2 Pulley         | 10 Generator drive belt  |
| 3 Adjusting link | 11 Capscrew              |
| 4 Capscrew       | 12 Fan adjusting screw   |
| 5 Shielded cable | 13 Fan drive belt        |
| 6 Receptacle     | 14 Water pump drive belt |
| 7 Generator      |                          |
| 8 Cover band     |                          |

Figure 50. Generator mounting and fan belt adjustment.

the generator receptacle (6).

- (3) Remove the capscrew (4), flat washer, and lockwasher that secure the generator to the adjusting link (3) and the two capscrews (1), lockwashers, and nuts that secure the generator to the bracket (9); remove the generator and the shims.
- (4) Remove the screw and lockwashers that secure the link (3) to the bracket; remove the link.
- (5) Remove the three capscrews and lockwashers that secure the bracket (9) to the engine; remove the bracket.

*e. Cleaning and Inspection.*

- (1) Clean the exterior of the generator with a cloth dampened in cleaning solvent. Make sure that the solvent does not get into the interior of the generator.
- (2) Clean all other parts in cleaning solvent; dry thoroughly.
- (3) Inspect the generator as directed in a and b above; make sure the cover band fits tightly around the generator opening. Rotate the generator armature shaft manually. It should rotate freely without binding or catching. Carefully check for signs of overheating and the odor of burned insulation.
- (4) Inspect the drive belt for wear, fraying, or deterioration; replace a worn or damaged drive belt.
- (5) Inspect all other parts for cracks, wear, damaged threads, or other damage; replace if damaged.

DEFLECTION EQUAL TO  
WIDTH OF BELT FOR  
EACH FOOT OF FREE  
SPAN

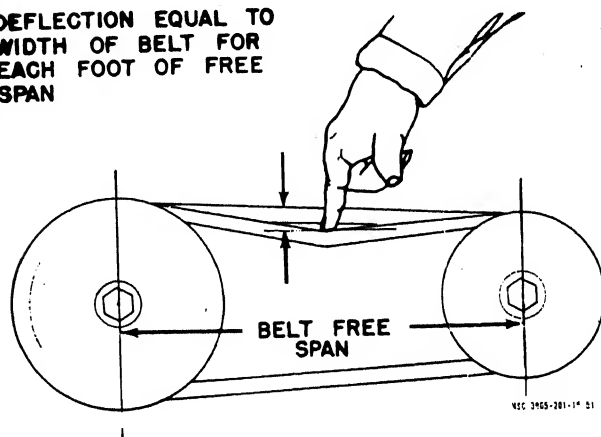
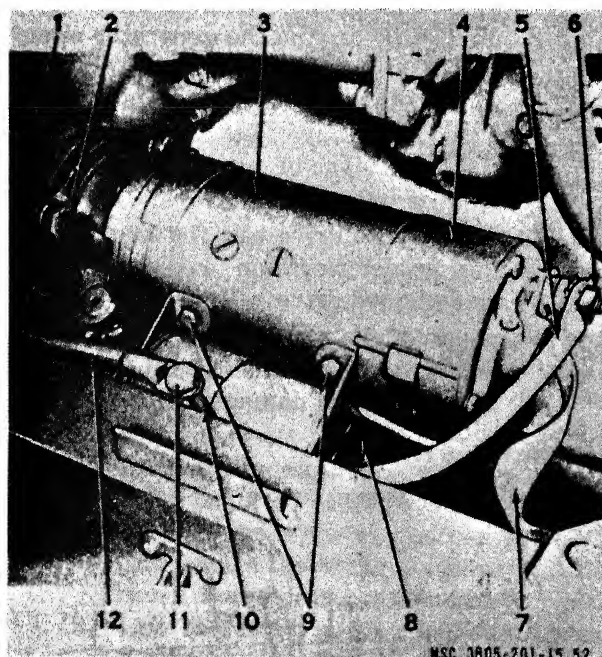


Figure 51. Checking belt tension.

*f. Installation.*

- (1) Position the bracket (9, fig. 50) on the engine; secure with three screws and lockwashers.
- (2) Position the adjusting link (3) on the bracket; secure with a screw and lockwashers; do not tighten the screw.
- (3) Position the shims and the generator (7) on the bracket; secure with two screws (1), flat washers, and lockwashers. Connect the link (3) to the generator with a screw, lockwashers, and a flat washer.
- (4) Connect a shielded cable (5) to the generator receptacle (6).
- (5) Install the generator drive belt (10) as directed in c(2) above; adjust as indicated in figure 51.
- (6) Polarize the generator as directed in *g* below.



- |                            |                                  |
|----------------------------|----------------------------------|
| 1 Flywheel housing         | 8 Starter switch assembly        |
| 2 Capscrew                 | 9 Capscrew                       |
| 3 Starting motor           | 10 Starter button-to-switch lead |
| 4 Cover band               | 11 Capscrew                      |
| 5 Battery-to-starter cable | 12 Battery-to-switch cable       |
| 6 Nut                      |                                  |
| 7 Ground strap             |                                  |

Figure 52. Starting motor installation.

*g. Polarizing Generator (fig. 50).*

- (1) After a generator has been repaired or tested and installed on a vehicle, it must be polarized to make sure that it has the correct polarity with respect to the battery it is to charge. Failure to polarize the generator may result in burned regulator contact points, a run-down battery, and possible serious damage to the generator.
- (2) When the generator has been mounted and connected, but before the engine is started, polarize the generator. Disconnect the generator-to-voltage regulator shielded cable (5) at the voltage regulator, and the battery connection cable from the voltage regulator; then momentarily connect a wire from the B terminal of the generator cable to the battery connection cable. This allows a momentary surge of current to flow through the generator field coils to correctly polarize the generator. Reconnect the cables to the voltage regulator.

**140. Voltage Regulator (fig. 30)**

*a. Removal.*

- (1) Remove the left rear side panel from the loader.
- (2) Disconnect the shielded generator cable (3) from the receptacle (13) on the voltage regulator (14). Disconnect the battery cable (16) from the receptacle (15) on the voltage regulator.
- (3) Remove the four capscrews and lockwashers that secure the voltage regulator to the mounting bracket; remove the voltage regulator.
- (4) Remove the four capscrews and lockwashers that secure the mounting bracket to the engine; remove the mounting bracket.

*b. Cleaning and Inspection.*

- (1) Clean the exterior of the voltage regulator with a cloth dampened with an approved cleaning solvent; dry thoroughly. Clean all other parts with solvent and blow dry with compressed air.
- (2) Inspect the voltage regulator for cracks, dented cover, damaged recep-



tacle, and signs of overheating. Replace if damaged.

- (3) Inspect the mounting bracket for cracks or distortion; replace if damaged.
- (4) Inspect the hardware parts for cracks, worn or damaged threads, distortion, or other damage; replace damaged parts.

*c. Installation.* Install the voltage regulator by reversing the removal procedure given in *a* above.

#### 141. Starting Motor (fig. 52)

*a. Brush Inspection and Replacement and Commutator Service.*

- (1) Remove the cover band (4) from the starting motor (3).
- (2) Inspect the brushes for wear and frayed or broken pigtails. If the pigtails are badly frayed or broken or if the brushes are worn to less than nine-sixteenths inch, replace the brushes.
- (3) Check that the commutator is clean and smooth. If it is dirty or lightly pitted, clean it with a fine commutator stone. If the pitted condition cannot be corrected with a stone, report the condition to higher authority.
- (4) Inspect the brush holder for proper mounting. If the holders are damaged or have stripped threads, report the condition to higher authority.
- (5) Check brush spring tension by hooking a spring scale under the brush spring and reading the tension on the scale as the end of the spring leaves the brush. The correct tension is 45 to 50 ounces.

*b. Removal.*

- (1) Disconnect the battery-to-switch cable (12) and the battery-to-starter cable (5) at the terminal block in the battery box. Tape the ends of the cables to prevent electrical contact.
- (2) Remove the left rear side panel from the loader.
- (3) Remove the nut (6) that secures the battery-to-starter cable and ground strap (7) to the stud at the rear of the starting motor (3).
- (4) Remove the capscREW (11) that se-

cures the battery-to-switch cable (12) and the starter button-to-switch lead (10) to the starter switch assembly (8). Disconnect the cables from the starter switch assembly.

- (5) Remove the three capscREWS (2) and lockwashers that secure the starting motor to the flywheel housing (1) of the engine; remove the starting motor.

*c. Cleaning and Inspection.*

- (1) Clean the exteriors of the starting motor and starter switch assembly with a cloth dampened with an approved cleaning solvent; dry thoroughly. Take care not to allow the solvent to enter either the inside of the motor or the starter switch assembly.
- (2) Clean all other parts with solvent; blow dry with compressed air.
- (3) Remove the cover band and inspect the starting motor as described in *a* above.
- (4) Check the starting motor for cracks, damaged clutch parts, and the odor of burned insulation.
- (5) If the starting motor is damaged, has worn or damaged brushes, or the commutator is damaged, report the condition to higher authority.

*d. Installation.* To install the starting motor, reverse the removal procedure given in *b* above.

#### 142. Headlights and Floodlights

*Note.* Headlights and floodlights are identical except that the sealed units used in the assemblies are different. Servicing and disassembly of the units are identical.

*a. Replacing Sealed Units.*

- (1) Spread apart the molded ring (1, fig. 53) and grasp the edge of the sealed unit (2). Pull outward to remove the sealed unit from the body and from the socket in the body.
- (2) Position the new sealed unit on the body so that the prongs of the unit engage the socket; spread the molded ring so that it engages the outer ring of the sealed unit and retains it in place.

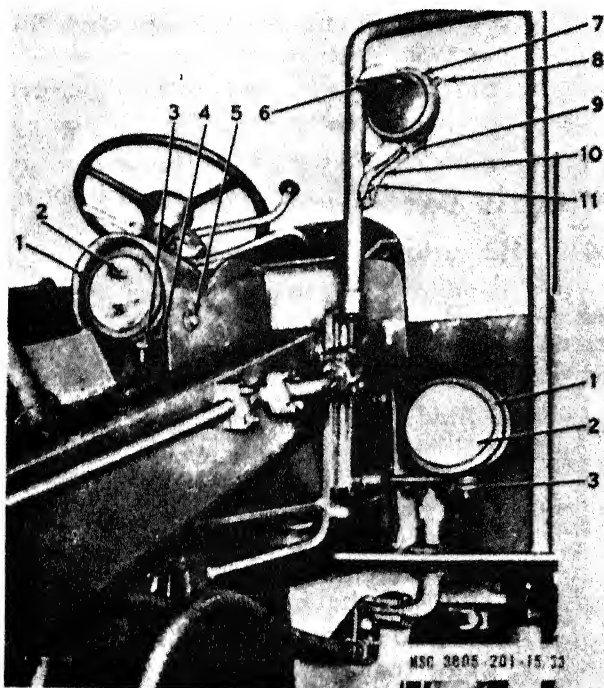
*b. Removal.*

- (1) Disconnect the electrical leads from the light unit.

- (2) Remove the nut (3) that secures the light unit to the bracket (4 or 12); remove the light unit.
- (3) Remove the capscrew (5), lockwasher, flat washer, and spacer that secure the bracket (4) to the enclosure; remove the bracket.
- (4) To remove the two rear floodlights (2, fig. 54), disconnect the leads from the lights and remove the nut (1) that secures each of the lights to the rear flood light enclosure; remove the lights.
- (5) Remove the sealed unit from each floodlight or headlight housing as described in subparagraph *a* above.

*c. Cleaning and Inspection.*

- (1) Clean each of the sealed units with a cloth dampened with water. Use soapy water to clean hard-to-remove stains.
- (2) Clean the light unit housing with a cloth dampened with an approved cleaning solvent; dry thoroughly.



- |               |                 |
|---------------|-----------------|
| 1 Molded ring | 7 Door assembly |
| 2 Sealed unit | 8 Captive screw |
| 3 Nut         | 9 Nut           |
| 4 Bracket     | 10 Bracket      |
| 5 Capscrew    | 11 Nut          |
| 6 Sealed unit | 12 Bracket      |

Figure 53. Front light installation.

- (3) Clean the hardware and brackets with solvent; dry thoroughly.
- (4) Inspect the sealed units for discoloration or damage; replace if necessary.
- (5) Inspect the brackets and hardware for cracks, worn or damaged threads, and distortion; replace damaged parts.

*d. Installation.* Install the headlights and floodlights by reversing the removal procedure given in subparagraph *b* above.

### 143. Blackout Headlight (fig. 53)

*a. Sealed Unit Replacement.*

- (1) Loosen the three captive screws (8) that secure the door assembly (7) to the body of the blackout headlight; remove the door, sealed unit (6), and three springs from the body. Disconnect the sealed unit leads from the connectors in the body.
- (2) Connect the electrical leads of a new sealed unit to the connectors in the body. Position the springs, door assembly (7), and sealed unit (6) on the blackout headlight body; secure by attaching the door assembly to the body with three captive screws (8).

*b. Removal.*

- (1) Disconnect the blackout headlight electrical leads.
- (2) Remove the nut (11) and lockwasher that secure the blackout headlight to the bracket (10); remove the blackout headlight.
- (3) Remove the sealed unit as directed in *a* above.

*c. Cleaning and Inspection.*

- (1) Clean the sealed unit and housing with a cloth dampened with an approved cleaning solvent; dry thoroughly.
- (2) Inspect the blackout headlight parts for cracks, distortion, worn or damaged threads, worn, frayed, or deteriorated insulation, or other damage; replace damaged parts.

*d. Installation.* Install the blackout headlight by reversing the removal procedure given in *b* above.



#### 144. Tail and Stoplight (fig. 54)

##### *a. Bulb Replacement.*

- (1) Loosen the six captive screws (9) that secure the door assembly (8) to the light body; remove the door assembly and gasket.
- (2) To remove the defective bulb, press inward, give the bulb a quarter turn, and pull out.
- (3) Insert a new bulb in the socket of the housing, press inward, and give the bulb a quarter turn to secure it to the socket.
- (4) Position the gasket and door assembly (8) on the housing; secure by tightening the six captive screws (9).

##### *b. Removal.*

- (1) Disconnect the electrical leads of the tail and stoplights.
- (2) Remove the two capscrews and lockwashers that secure each of the two tail and stoplights to the frame; remove the tail and stoplights.

##### *c. Cleaning and Inspection.*

- (1) Clean the lamp bulbs and lenses with a cloth dampened with water.
- (2) Clean all metallic parts with a cloth dampened with an approved cleaning solvent; dry thoroughly.
- (3) Inspect the bulbs for discoloration of the glass and for damaged pins on the bayonet base; replace damaged bulbs.
- (4) Inspect leads and sockets for cracks, damaged insulation, and deterioration. Inspect metallic parts for cracks or distortion. Replace damaged parts.

*d. Installation.* Install the tail and stoplights by reversing the removal procedure given in *b* above.

#### 145. Blackout Stoplight (fig. 54)

##### *a. Bulb Replacement.*

- (1) Remove the two machine screws (4) that hold the door assembly (5) of the blackout stoplight to the body (3); remove the door.
- (2) Press inward and give the bulb a quarter turn to release it from the socket in the body.
- (3) Insert a new bulb in the socket, de-

press, and give it a quarter turn to secure it to the socket.

- (4) Position the door assembly on the body; secure with two machine screws.

##### *b. Removal.*

- (1) Disconnect the blackout stoplight electrical leads.
- (2) Remove the capscrew and lockwasher that secure the blackout stoplight to the bracket (7); remove the stoplight.
- (3) Remove the door assembly and bulb from the blackout spotlight as directed in *a* above.

##### *c. Cleaning and Inspection.*

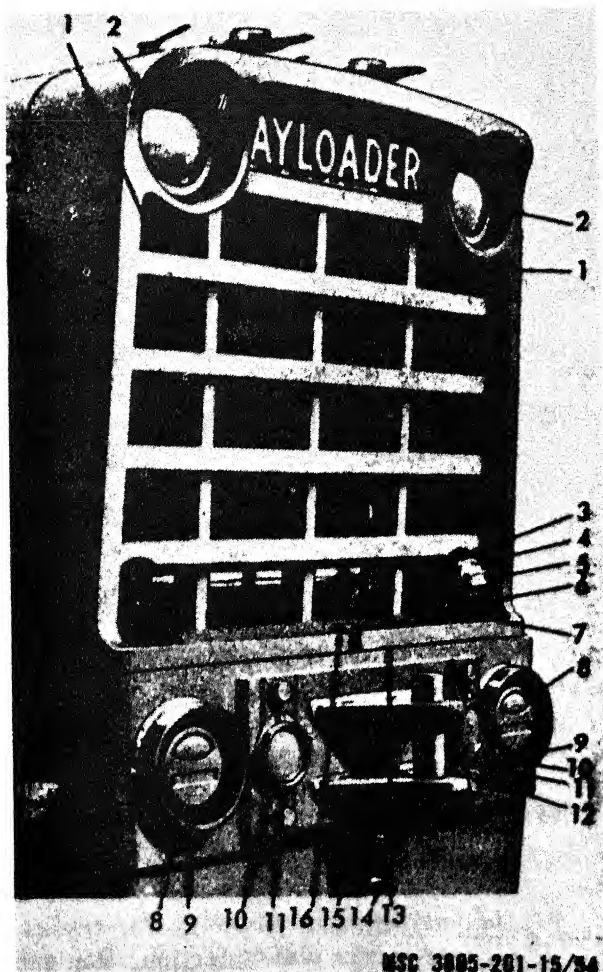
- (1) Clean the bulb and the lens with warm soapy water.
- (2) Clean the interior and exterior of the body with a cloth dampened with an approved cleaning solvent; dry thoroughly.
- (3) Clean all other parts with an approved cleaning solvent; dry thoroughly.
- (4) Inspect the bulb for discoloration and for damaged pins on the bayonet base; replace if necessary.
- (5) Inspect the door assembly for cracks, damaged lens, and distortion. Replace damaged door.
- (6) Inspect the body for cracks, distortion, and frayed or deteriorated lead insulation; replace if damaged.

*d. Installation.* Install the blackout stoplight by reversing the removal procedure described in *b* above.

#### 146. Miscellaneous Electrical Components

##### *a. Removal.*

- (1) Disconnect the electrical lead from the low air pressure warning buzzer (31, fig. 4) mounted on the front panel of the operator's compartment. Remove the two capscrews and lockwashers that secure the buzzer to the panel; remove the buzzer.
- (2) Disconnect the electrical leads from the troublelight socket (17, fig. 10). Remove the two machine screws that secure the socket to the switch panel (23); remove the socket.



- |                                    |                  |
|------------------------------------|------------------|
| 1 Nut                              | 9 Captive screw  |
| 2 Floodlight                       | 10 Reflector     |
| 3 Blackout stoplight body          | 11 Capscrew      |
| 4 Machine screw                    | 12 Hitch pin     |
| 5 Door assembly                    | 13 Grille        |
| 6 Nut                              | 14 Counterweight |
| 7 Bracket                          | 15 Capscrew      |
| 8 Tail and stoplight door assembly | 16 Capscrew      |

Figure 54. Rear light installation.

- (3) Disconnect the electrical leads of the receptacle (17, fig. 47) from the terminal block (21). Remove the capscrews (18), nuts (20), and lockwashers (19) that secure the receptacle to the battery box (16); remove the receptacle.
  - (4) Disconnect all leads to the terminal block (21). Remove the capscrews (22), nuts (12), and lockwashers (11) that secure the terminal block to the top of the battery box; remove the terminal block.
- b. *Cleaning Inspection.*
- (1) Clean all electrical parts with a cloth lightly dampened with an approved cleaning solvent. Wash all other parts in solvent.
  - (2) Inspect the troublelight socket and the receptacle for cracks, damaged terminals, broken leads, and other damage; replace damaged parts.
  - (3) Inspect the terminal block for cracks, worn or damaged threads, or other damage; replace if damaged.
  - (4) Inspect all other parts for cracks, distortion, or worn or damaged threads; replace damaged parts.

c. *Installation.* Install the miscellaneous electrical components by reversing the removal procedure given in a above.

## Section VII. COOLING SYSTEM

### 147. Description (fig. 55)

a. The engine cooling system automatically maintains the most efficient engine temperature under all normal conditions of operation. Liquid coolant is circulated through the engine oil cooler, cylinder block, cylinder head, and air compressor, where it absorbs heat caused by combustion and friction. The temperature of the coolant is controlled by a thermostat located

in a housing (12) at the top front of the engine. The thermostat remains closed and prevents the flow of coolant through the radiator until the coolant in the engine has reached a high enough temperature to enable the engine to operate at maximum efficiency. The coolant then passes from the thermostat housing through a hose (8) to the radiator (10), where air forced through the radiator by the fan carries away the heat thrown off by the coolant. The coolant

then passes through another hose from the radiator to the water pump where its velocity is increased before it recirculates through the engine and repeats the cycle.

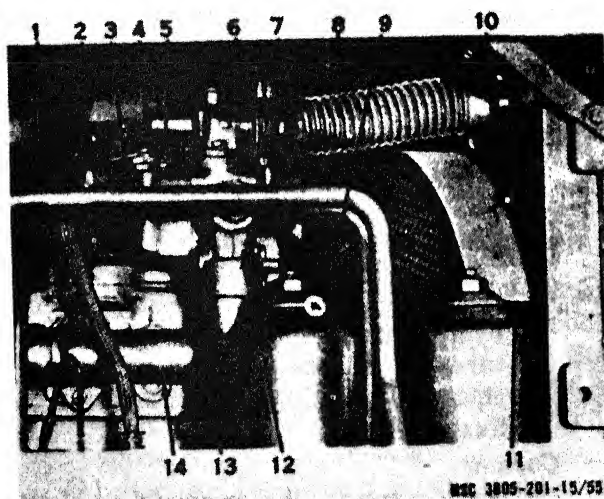
b. Carefully check the cooling system at frequent intervals. Proper regulation of engine coolant heat is very important. Underheating results in inefficient engine operation and excessive wear. Overheating results in excessive wear and oil consumption and can cause failure of seals and bearings.

#### 148. Servicing the Cooling System

##### a. Filling (fig. 55).

**Caution:** Avoid adding water to a hot engine. Wait until the engine has cooled, whenever possible. If it is absolutely necessary to add water to a hot engine, add the water SLOWLY while the engine is running at a fast idle.

- (1) Check to be sure the radiator, engine cylinder block, water pump body, and air compressor drain cocks are closed.
- (2) Remove the radiator cap and fill the cooling system with clean, fresh water (approx. 36 quarts). Open the vent



- |                                |                                |
|--------------------------------|--------------------------------|
| 1 Lubricating oil tube         | 8 Upper radiator hose          |
| 2 Temperature sender lead      | 9 Compressor water outlet tube |
| 3 Cylinder head outlet         | 10 Radiator                    |
| 4 Temperature sender           | 11 Cooling fan guard           |
| 5 Thermostat housing vent cock | 12 Thermostat housing          |
| 6 Water outlet connection      | 13 Water bypass coupling       |
| 7 Hose clamp                   | 14 Exhaust manifold            |

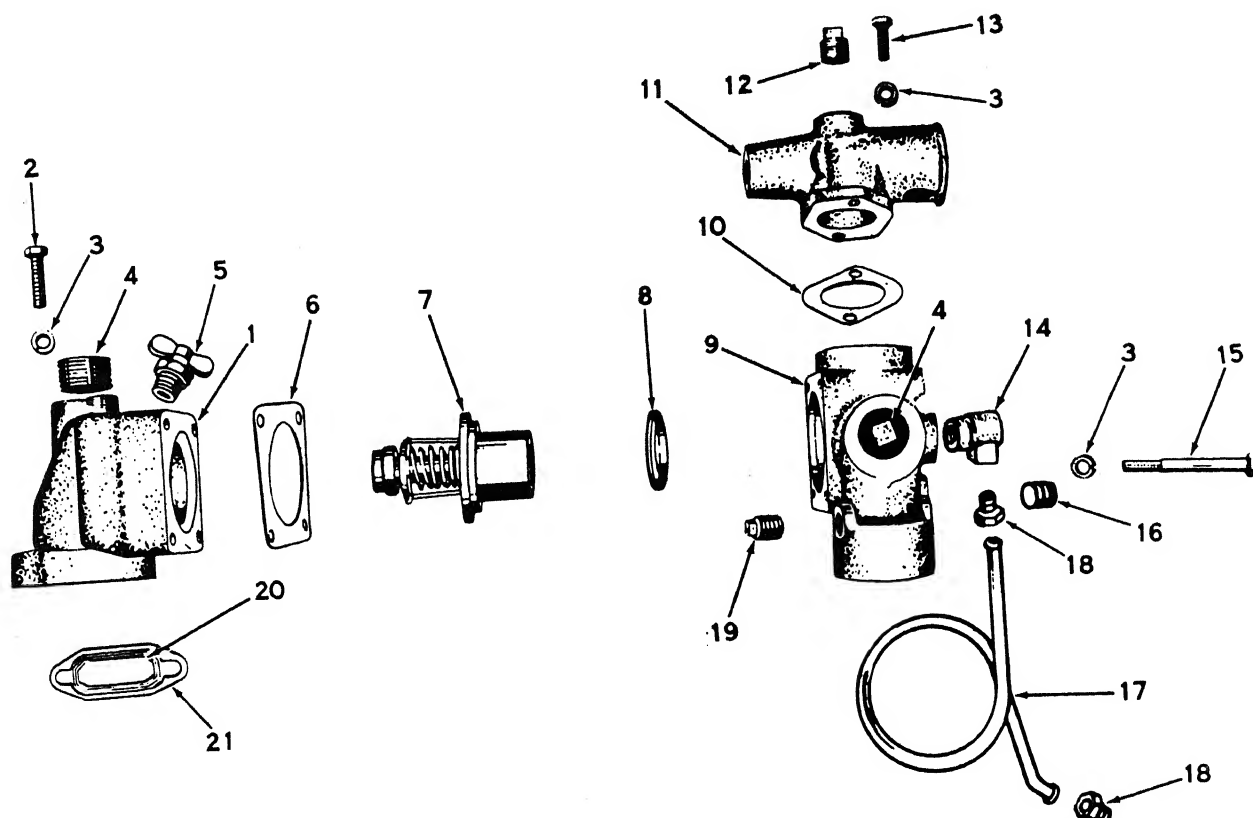
Figure 55. Thermostat housing and radiator installation.

cock at the top of the thermostat housing to allow the trapped air to escape; close the vent cock when water begins to flow from it. Install the cap on the radiator. When temperatures below freezing are expected, add a sufficient quantity of a permanent antifreeze to assure adequate protection from freezing.

- (3) Start the engine; let it come up to operating temperature to circulate the water and open the thermostat. Remove the radiator carefully to avoid being burned; check the water level.
- (4) If it is necessary to add water, add it slowly with the engine running at idle.
- (5) If it becomes necessary to add water at frequent intervals, investigate the cause of the coolant loss, as severe damage could result.

##### b. Draining and Cleaning.

- (1) **Draining.** Open the water pump body drain cock (7, fig. 58), radiator base drain cock, engine cylinder block drain cock, and the air compressor drain cock. Open the vent cock (5, fig. 55) at the top of the thermostat housing and remove the radiator cap.
- (2) **Flushing.** Run water through the cooling system with the drain cocks open until the water coming out is clean.
- (3) **Pressure flushing.**
  - (a) Remove the radiator end of the upper radiator hose and the engine end of the lower radiator hose. Install the radiator cap.
  - (b) Attach a flushing gun to the lower radiator hose; let the water run until the radiator is full.
  - (c) When the radiator is full, apply air pressure gradually to avoid damage to the radiator core.
  - (d) Shut off the air; allow the radiator to fill with water again.
  - (e) Repeat (c) and (d) above until the water coming from the radiator is clean.
  - (f) Remove the thermostat as directed in paragraph 149a; install the thermostat housing (without the thermostat) on the engine.



MSC 3805-201-15/56

- |                                   |                      |                            |                      |
|-----------------------------------|----------------------|----------------------------|----------------------|
| 1 Cylinder head outlet connection | 6 Gasket             | 11 Water outlet connection | 16 Plug              |
| 2 Screw                           | 7 Thermostat         | 12 Plug                    | 17 Tube              |
| 3 Lockwasher                      | 8 Thermostat seal    | 13 Screw                   | 18 Nut               |
| 4 Plug                            | 9 Thermostat housing | 14 Restrictive elbow       | 19 Plug              |
| 5 Vent cock                       | 10 Gasket            | 15 Screw                   | 20 Connection insert |
|                                   |                      |                            | 21 Connection plate  |

Figure 56. Thermostat housing, exploded view.

- (g) Attach the flushing gun to the upper hose connection of the engine; partially block the lower connection until the engine fills with water.
- (h) Make sure the drain cock at the water pump is open. Apply air pressure to force the water, rust, and sediment from the lower opening.
- (i) Repeat (g) and (h) above until the water coming from the engine is clean.
- (j) Install the thermostat in the housing as directed in paragraph 149d.
- (k) Connect the upper and lower radiator hoses; secure with the hose clamps.
- (l) Close the drain cocks and fill the radiator as directed in subparagraph a above.

- (4) *Chemical cleaning.* If excessive rust and scale are present in the cooling system, clean the system with a good cleaner such as sodium bisulphate or oxalic acid, according to the manufacturer's recommendations. Follow chemical cleaning by neutralizing and flushing.

c. *Coolant.*

- (1) *Requirements.* Water should be clean and free of any corrosive chemicals such as chlorides, sulphates, and acids. It should be kept slightly alkaline with a pH value in the range of 8.5 to 10.5. Any water which is suitable for drinking can be treated as follows to make it suitable for use in an engine.

(2) *Treatment.*

- (a) *Summer.* Use 1 ounce of chromate

compound for every 2 or 3 gallons of water. This is equivalent to 1,700 to 2,500 parts per million.

- (b) *Winter.* Use ethylene-glycol base antifreeze in the percentage required for winter protection. Do not use a corrosion inhibitor in addition to antifreeze.

## 149. Thermostat Housing

### a. Removal.

- (1) Drain the cooling system as directed in paragraph 148b(1).
- (2) Disconnect the lead (2, fig. 55) from the temperature sender (4); remove the temperature sender from the cylinder head outlet (3).
- (3) Disconnect the air compressor water outlet tube (9) from the thermostat housing (12).
- (4) Disconnect the air bleed tube (17, fig. 56) from the thermostat housing.
- (5) Remove the clamp that secures the generator-to-regulator cable to the thermostat housing.
- (6) Loosen the hose clamp (7, fig. 55) that secures the hose (8) to the water outlet connection (6).
- (7) Remove the two screws (2, fig. 56) and lockwashers (3) that secure the assembled thermostat housing and water connections to the cylinder head; remove the thermostat housing and connection plate (21).

### b. Disassembly (fig. 56).

- (1) Remove the four screws (15) and lockwashers (3) that secure the cylinder head outlet connection (1) to the thermostat housing (9); remove the outlet connection, gasket (6), thermostat (7), and the seal (8).
- (2) Remove the plug (4) and the vent cock (5) from the cylinder head outlet connection.
- (3) Remove the two screws (13) and the lockwashers (3) that secure the water outlet connection (11) to the thermostat housing; remove the water outlet connection and gasket (10).
- (4) Remove the plug (12) from the water outlet connection.
- (5) Remove the plugs (4, 16, and 19) and

the restrictive elbow (14) from the thermostat housing.

### c. Cleaning and Inspection.

- (1) Clean all dirt, scale, and corrosion from the parts.

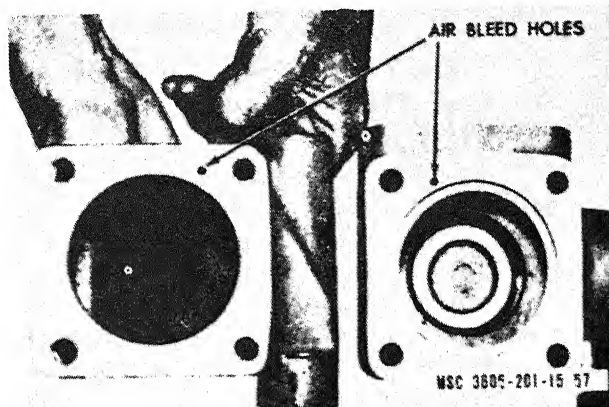
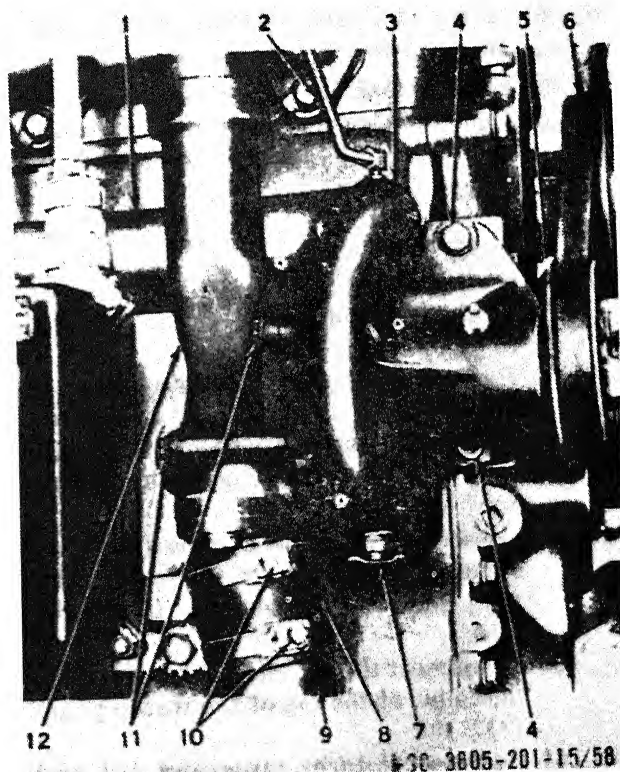


Figure 57. Thermostat housing and seal.



- |                         |                     |
|-------------------------|---------------------|
| 1 Oil cooler connection | 7 Drain cock        |
| 2 Air bleed tube        | 8 Hose              |
| 3 Water pump            | 9 Outlet tube       |
| 4 Capscrew              | 10 Hose clamps      |
| 5 Water pump sheave     | 11 Capscrew         |
| 6 Water pump drive belt | 12 Water pump cover |

Figure 58. Water pump installation.

- (2) Carefully scrape all gasket and seal fragments from the thermostat housing and water outlet connections. Clean the air bleed holes (fig. 57) with compressed air.
- (3) Inspect the thermostat housing and the water outlet connections for cracks, breaks, or other damage.
- (4) Inspect the thermostat for deterioration and distortion.
- (5) Test the thermostat by suspending it and an accurate thermometer in a container of water; apply heat and observe the operating point. Check the heat opening range stamped on the thermostat, as special thermostats are sometimes used. The standard thermostat should start to open at 185° F. and be completely open at 195° F. Replace the thermostat if it does not operate in the correct range.
- (6) Replace all gaskets, the seal, and damaged or defective parts.

*d. Reassembly and Installation.* Reassemble and install the thermostat housing by reversing the removal and disassembly procedure described in *a* and *b* above.

## 150. Water Pump

### *a. Removal* (fig. 58).

- (1) Drain the cooling system as directed in paragraph 148b(1).
- (2) Remove the engine oil filter as directed in paragraph 155b.
- (3) Loosen the fan adjusting screw sufficiently to remove the water pump drive belt (6).
- (4) Loosen the two hose clamps (10) that secure the hose (8) to the outlet tube (9); slide the hose from the outlet tube.
- (5) Disconnect the air bleed tube (2) from the elbow at the top of the water pump (3).
- (6) Remove the three capscrews (4) and lockwashers that secure the water pump to the engine gear cover, and the five capscrews (11) and lockwashers that secure the pump to the water pump cover (12); pull the water pump from the water pump cover (12) and the oil cooler connection (1).

### *b. Cleaning and Inspection.*

- (1) Clean the exterior of the water pump with a cloth dampened with an approved solvent.
- (2) Flush all dirt and corrosion from the water pump.
- (3) Inspect the water pump for excessive wear or damage; repair or replace a defective water pump.
- (4) Inspect the hoses for cracks or deterioration; inspect the hose clamps for cracks or damage. Replace unserviceable parts.

### *c. Installation* (fig. 58).

- (1) Position new preformed packings on the water pump cover and the oil cooler connection (1).
- (2) Carefully position the water pump (3) over the water pump cover and the oil cooler connection; secure to the engine gear cover with the three capscrews (4) and lockwashers, and to the water pump cover (12) with five capscrews (11) and lockwashers.
- (3) Slide the hose (8) into position on the outlet tube (9); secure with the two hose clamps (10).
- (4) Connect the air bleed tube (2) to the elbow at the top of the water pump;
- (5) Position the water pump drive belt (6) on the sheave (5).
- (6) Adjust the tension of the water pump drive belt as directed in *d* below.

### *d. Belt Adjustment.*

- (1) Adjust the tension of the fan belts as directed in paragraph 152e.
- (2) Remove the three screws from the water pump sheave as shown in figure 59; loosen the center screw in the water pump shaft.
- (3) Turn the adjusting sheave on the fixed sheave so that the deflection of the belt when depressed at the center of the span equals the width of the belt for each 12 inches of free span.
- (4) When the proper tension is obtained, aline the holes of the adjusting sheave with the fixed sheave; secure with the three screws and lockwashers. Tighten the screw in the center of the water pump shaft.



## 151. Radiator and Converter Oil Cooler

(fig. 60)

### a. Removal.

- (1) Drain the cooling system as directed in paragraph 148b.

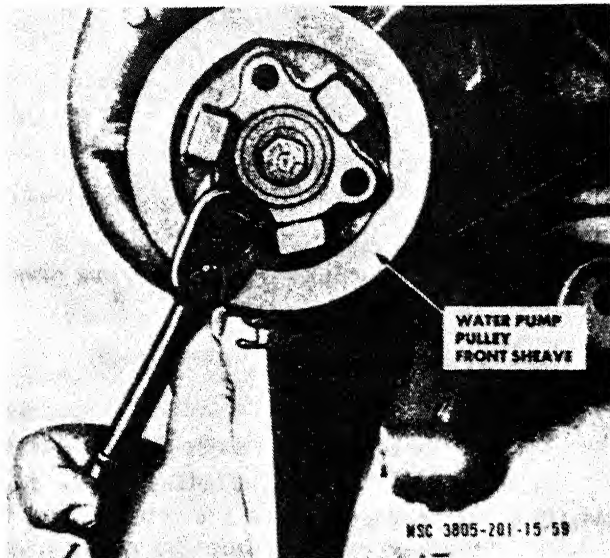
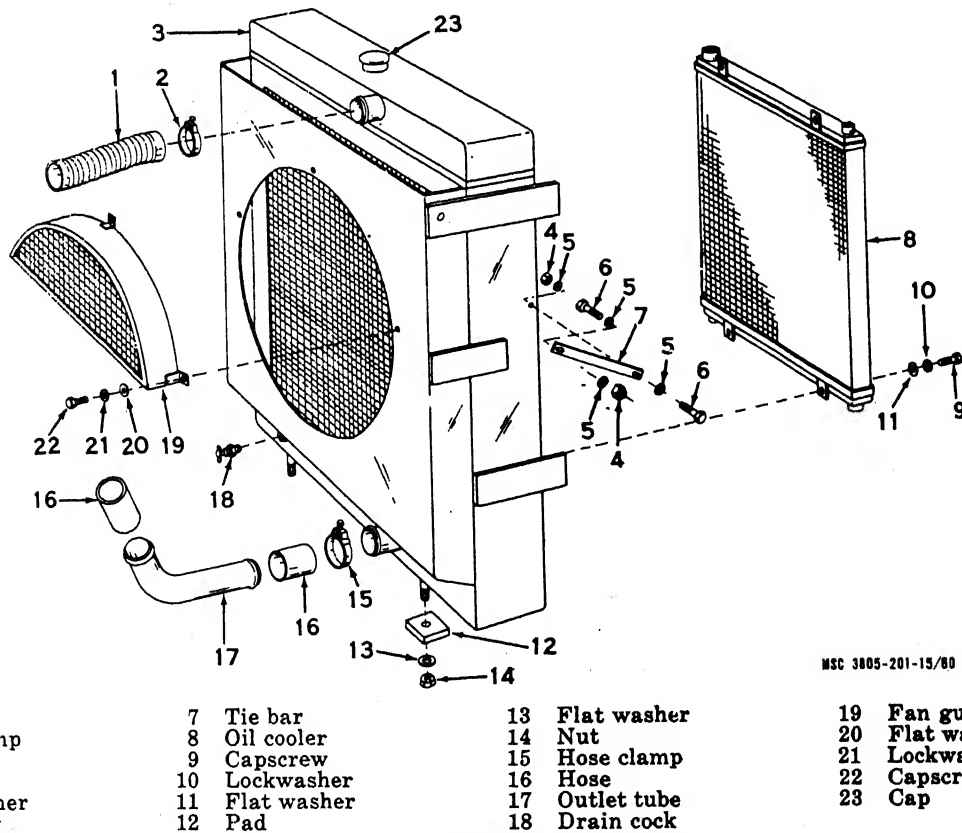


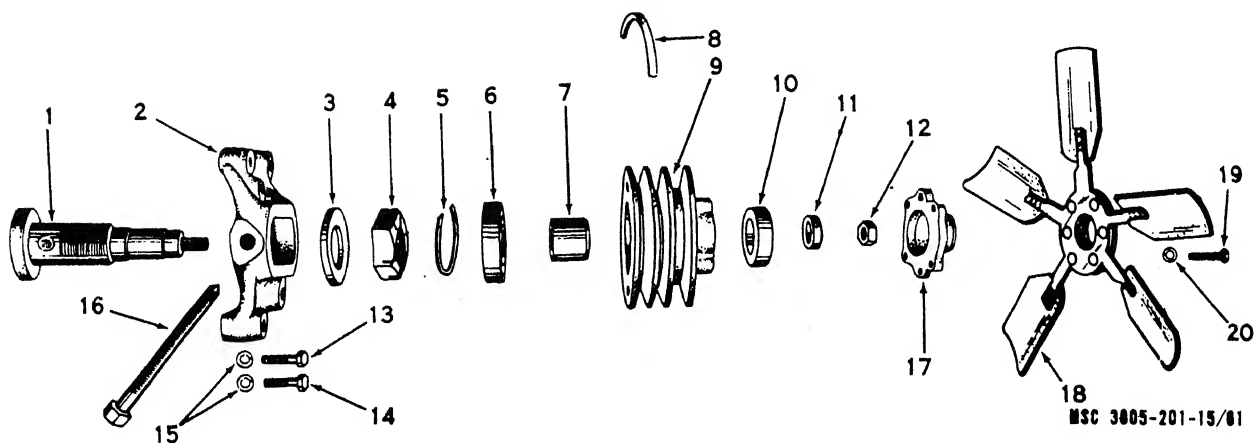
Figure 59. Adjusting water pump drive belt tension.

- (2) Drain the oil cooler.
- (3) Remove the rear hood and grille as directed in paragraphs 182a and 178a.
- (4) Remove the four capscrews (9), lockwashers (10), and flat washers (11) that secure the oil cooler (8) to the radiator; remove the oil cooler.
- (5) Loosen the two hose clamps (2) and disconnect the hose (1) from the radiator and from the thermostat outlet connection. Remove the hose clamps from the hose.
- (6) Loosen the four hose clamps (15) and remove and disassemble the outlet tube (17) and hoses (16) from the bottom of the radiator and from the water pump inlet.
- (7) Remove the three capscrews (22), lockwashers (21), and flat washers (20) that secure the fan guard (19) to the radiator (3); remove the fan guard.
- (8) Support the radiator (3) with a hoist and remove the two nuts (14) and flat washers (13) that secure the radiator



- |               |                |                |                |
|---------------|----------------|----------------|----------------|
| 1 Hose        | 7 Tie bar      | 13 Flat washer | 19 Fan guard   |
| 2 Hose clamp  | 8 Oil cooler   | 14 Nut         | 20 Flat washer |
| 3 Radiator    | 9 Capscrew     | 15 Hose clamp  | 21 Lockwasher  |
| 4 Nut         | 10 Lockwasher  | 16 Hose        | 22 Capscrew    |
| 5 Flat washer | 11 Flat washer | 17 Outlet tube | 23 Cap         |
| 6 Capscrew    | 12 Pad         | 18 Drain cock  |                |

Figure 60. Radiator, exploded view.



1 Fan hub shaft	6 Bearing	11 Cone clamp washer	16 Fan adjusting screw
2 Fan bracket	7 Bearing spacer	12 Nut	17 Fan spacer
3 Washer	8 Fan drive belts	13 Screw	18 Fan
4 Nut	9 Fan pulley	14 Screw	19 Screw
5 Snap ring	10 Bearing	15 Lockwasher	20 Lockwasher

Figure 61. Fan, fan bracket, and hub, exploded view.

to the frame; remove the radiator and mounting pads (12).

- (9) Remove the drain cock (18) from the radiator.

*b. Cleaning and Inspection.*

- (1) Remove all dust and dirt from the exterior of the radiator with water pressure.
- (2) Clean the radiator by pressure flushing or chemical cleaning as directed in paragraph 148b (3) or (4).
- (3) Clean the oil cooler fins with compressed air. Flush the inside of the oil cooler with an approved cleaning solvent. Blow all solvent from the oil cooler with compressed air.
- (4) Inspect the radiator and oil cooler for cracks, leakage, bent fins, or other damage; repair or replace if defective.
- (5) Inspect the hoses for cracks or deterioration.
- (6) Inspect the drain cock and hose clamps for proper operation; replace unserviceable parts.

*c. Installation.* Install the radiator by reversing the removal procedure described in subparagraph *a* above.

## 152. Fan and Bracket

*a. Removal.*

- (1) Remove the three capscrews (22, fig. 60), lockwashers (21), and flat washers (20) that hold the fan guard (19)

to the radiator; remove the fan guard.

- (2) Loosen the fan adjusting screw (12, fig. 50) to relieve the tension on the fan and water pump drive belts; remove the belts from the accessory drive, fan, and water pump pulleys.
- (3) Remove the four screws (13 and 14, fig. 61) and lockwashers (15) that secure the fan bracket (2) to the engine; remove the assembled fan and bracket.

*b. Disassembly (fig. 61).*

- (1) Remove the six screws (19) and lockwashers (20) that secure the fan (18) and fan spacer (17) to the fan pulley (9); remove the fan and the fan spacer.
- (2) Remove the nut (12) and the cone clamp washer (11) that secure the fan pulley (9) to the fan hub shaft (1); remove the assembled fan pulley.
- (3) Remove the snap ring (5) from the fan pulley; remove the large bearing (6), bearing spacer (7), and small bearing (10) from the fan pulley.
- (4) Remove the nut (4) and the washer (3) from the fan hub shaft.
- (5) Remove the fan adjusting screw (16) from the fan hub shaft and bracket; remove the fan hub shaft.

*c. Cleaning and Inspection.*

- (1) Wipe the dirt and grease from the bearings with a clean, dry cloth.



- (2) Clean the remaining parts with an approved cleaning solvent; dry with compressed air.
- (3) Inspect the bearings for rough or binding operation, excessive wear, looseness, or other damage.
- (4) Inspect the fan hub shaft for scored or damaged bearing seats or damaged threads.
- (5) Inspect the bracket, the pulley, and the spacers for cracks or damage.
- (6) Inspect the fan for loose blades, cracking, or distortion.
- (7) Replace the fan drive belts if excessively worn, frayed, or stretched.
- (8) Replace all damaged or excessively worn parts.

*d. Assembly and Installation.* Lubricate bearings and assemble and install the fan and bracket by reversing the disassembly and re-

moval procedure described in *a* and *b* above.

*e. Belt Adjustment.*

- (1) Turn the fan adjusting screw (16, fig. 61) to adjust the tension of the fan drive belts (8).
- (2) The proper tension is obtained when the pressure of the index finger will depress the belt as shown in figure 51. The index finger should be extended straight down; the force exerted should be approximately 13 pounds.
- (3) After proper tension of the fan drive belts has been established, adjust the water pump drive belt as directed in paragraph 150d.
- (4) When new belts have been installed, recheck the adjustment after a short period of operation; if the belt can be pushed one-sixteenth inch more than recommended, readjust the tension.

## Section VIII. ENGINE LUBRICATING SYSTEM

### 153. General

*a.* The engine lubricating system distributes a supply of lubricating oil to the air compressor in addition to all the internal moving parts of the engine. Lubricating oil, drawn from the sump in the oil pan, is placed under pressure by the oil pump and flows through the lubricating oil filter, through passages in the cylinder block to the oil cooler, and through passages and ports to all working parts of the engine.

*b.* The lubricating oil pressure is controlled by a pressure control valve mounted on the engine at the right side of the loader. Normal oil pressure is 15 to 55 psi with the engine advancing from idle to governed speed; normal oil pressure at governed speed is maintained at 30 to 50 psi.

*c.* The oil cooler transfers excess heat of the lubricating oil to the engine coolant which circulates through it.

*d.* The lubricating oil filter is used to keep the oil clean by straining out grit, sludge, and other undissolved material. The filters will not remove foreign material which is dissolved in the lubricating oil, such as acids. The filters should be serviced and the lubricating oil changed at regular intervals as directed on the lubrication order (fig. 27).

### 154. Servicing the Lubrication System

*a. General.* The dipstick oil level gage (18, fig. 35), located on the right side of the loader, has a high (H) and a low (L) level mark to indicate the lubricating oil supply.

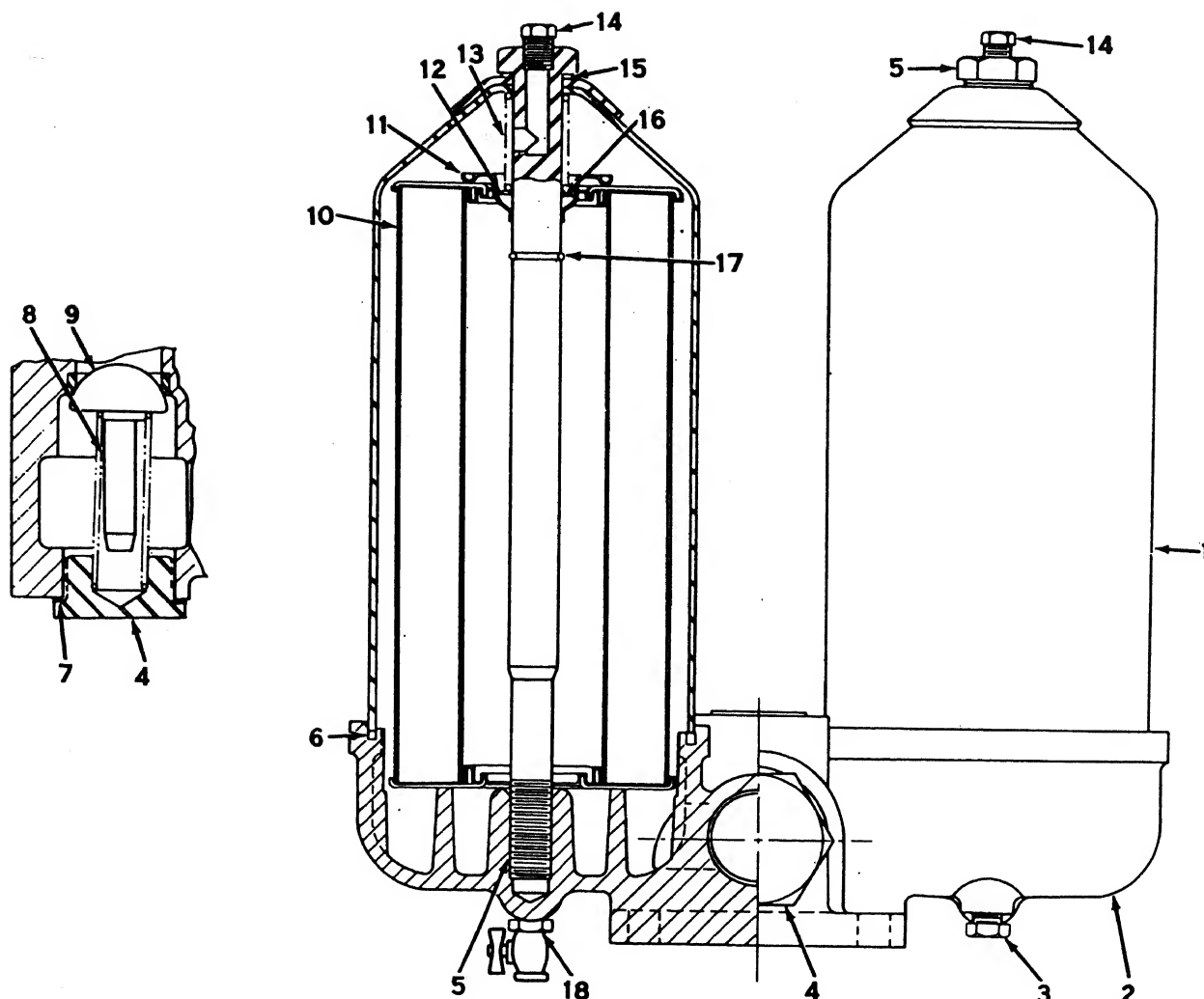
*b. Draining.*

*Note.* The engine should always be operated long enough to thoroughly warm the lubricating oil before draining. Warm oil will run off internal surfaces faster, drain more completely from engine-operated accessories, and carry more dirt and sludge with it.

- (1) Place a suitable container (approx. 5-gallon capacity) under the engine oil drain plugs (3, fig. 14). Remove the drain plugs.
- (2) Open the oil drain cock (11, fig. 30) from the one section of the lubricating oil filter (8) to drain it.
- (3) Service the lubricating oil filters as directed in paragraph 155.

*c. Filling.*

- (1) Install the drain plugs in the oil drain ports.
- (2) Close the drain cock at the bottom of the lubricating oil filter.
- (3) Remove the oil filler cap and add 16 quarts of the proper grade of lubricating oil (fig. 27) to the crankcase.
- (4) Start the engine and allow it to run for several minutes. Check for oil



MSC 3805-201-15/62

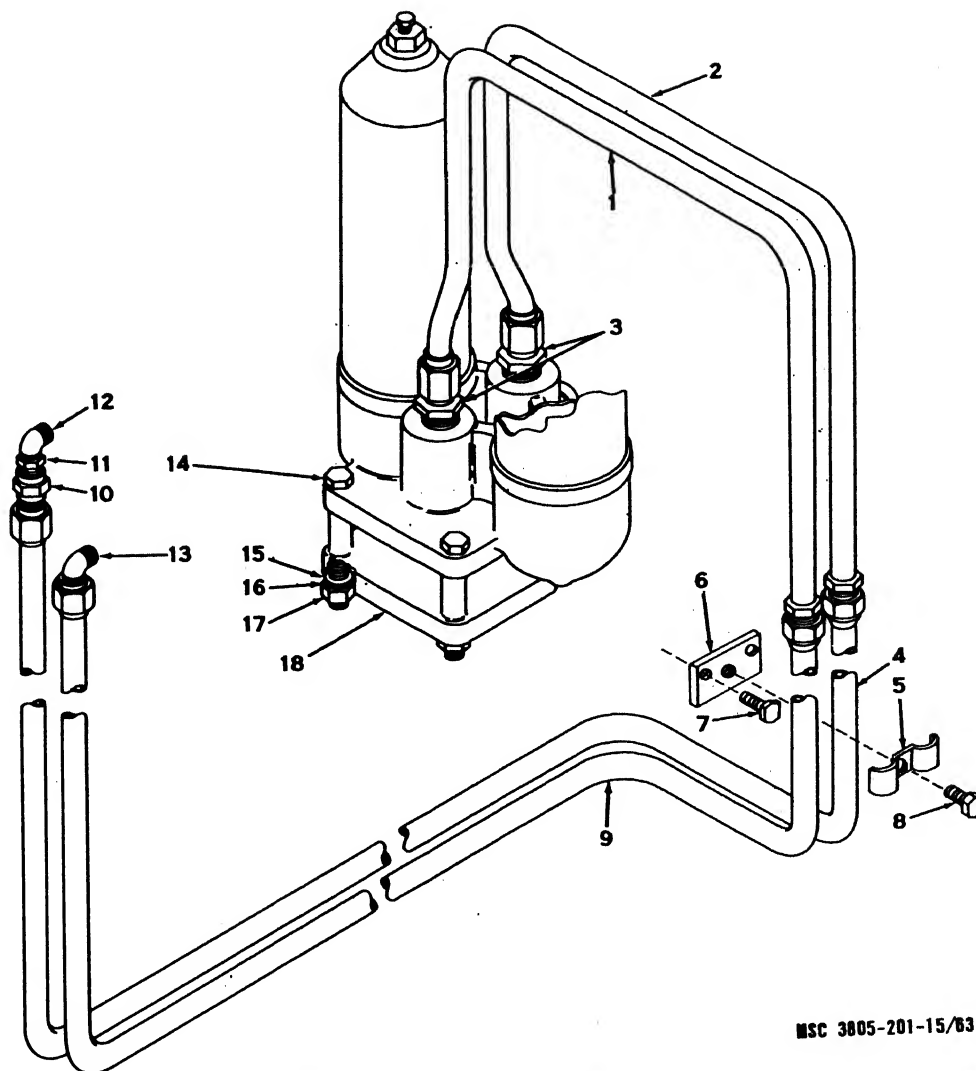
- |               |                     |                     |                   |
|---------------|---------------------|---------------------|-------------------|
| 1 Shell       | 6 Base gasket       | 11 Element retainer | 15 Stud gasket    |
| 2 Base        | 7 Valve-plug gasket | 12 Stud gasket      | 16 Stud washer    |
| 3 Plug        | 8 Valve spring      | 13 Spring           | 17 Retaining ring |
| 4 Valve plug  | 9 Bypass valve      | 14 Plug             | 18 Drain cock     |
| 5 Center stud | 10 Filter element   |                     |                   |

Figure 62. Engine lubrication filter, sectional view.

leakage around oil filters or drain plugs. Stop the engine and check the oil level with the dipstick oil level gage. Oil level should be near the high (H) level mark.

**d. Flushing.** Every 120 hours, inspect the condition of the rocker levers and crankcase for sludge. Normally, if a good grade of heavy-duty oil has been used and operating temperatures have been kept in the correct range, there should be no sludge in the engine and flushing will not be necessary. If inspection shows a large amount of sludge, the engine should be flushed as follows:

- (1) Drain the crankcase as directed in *b* above and install the drain plugs.
- (2) Install clean lubricating oil filter elements or elements used only for flushing operations.
- (3) Fill the crankcase with a mixture of 13 quarts of clean fuel oil to 3 quarts of clean lubricating oil. Check the dipstick oil level during filling.
- (4) Cover the radiator sufficiently to bring the coolant temperature up to 190° F. by running the engine for 15 minutes at 800 to 900 rpm. Sludge is heavy



MSC 3805-201-15/83

- |              |                  |                |                            |
|--------------|------------------|----------------|----------------------------|
| 1 Upper tube | 6 Bracket        | 11 Adapter     | 16 Lockwasher              |
| 2 Upper tube | 7 Capscrew       | 12 90° adapter | 17 Nut                     |
| 3 Adapter    | 8 Capscrew       | 13 90° adapter | 18 Filter mounting bracket |
| 4 Lower tube | 9 Lower tube     | 14 Capscrew    |                            |
| 5 Tube clamp | 10 Union adapter | 15 Flat washer |                            |

Figure 63. Engine lubrication lines, exploded view.

- and gummy and must be hot for the flashing oil to cut it properly.
- (5) Shut the engine down and drain the crankcase as directed in *b* above, allowing engine and accessories at least 30 minutes to drain. Crankcase and accessories must be drained thoroughly.
  - (6) Fill the crankcase as directed in *c* above.
  - (7) Service the lubricating oil filter, using new filter cartridges as directed in paragraph 155a.
  - (8) Start the engine and inspect for leaks.

## 155. Lubricating Oil Filter

### a. Servicing.

- (1) Service the lubricating oil filter at the interval recommended in the lubrication order (fig. 27). Service the filter to coincide with regularly scheduled oil changes.
- (2) Drain the engine lubricating oil as directed in paragraph 154b. Be sure to open the drain cock (11, fig. 30) to drain the filters before servicing.
- (3) Unscrew each assembled center stud (5, fig. 62) and shell (1) from the filter base (2); remove both assem-

blies and both gaskets (6) from the filter base.

- (4) Remove both filter elements (10) from the shells (1).
- (5) Clean the inside of the shells (1) with a clean cloth.
- (6) Place a new filter element (10) into each shell (1); install a new gasket (6) into each side of the base (2).
- (7) Install each assembled center stud (5) and shell (1) into the filter base (2); tighten each stud to 50 plus or minus 5 foot-pounds torque.
- (8) Close the drain cock (11, fig. 30) in the one section of the filter.

*b. Removal and Disassembly.*

- (1) Open the drain cock (18, fig. 62) from the one section of the filter and allow the oil to drain into a suitable container. Remove the drain plug (3) from the other section.
- (2) Loosen the tube nuts and remove the upper tubes (1 and 2, fig. 63) from the adapters (3) in the filter and from the lower tubes (4 and 9); remove the tubes and the adapters.
- (3) Remove the four capscrews (14), lockwashers (16), nuts (17), and two flat washers (15) that secure the filter and filter mounting bracket (18) to the loader; remove the filter and bracket from the loader.
- (4) Unscrew each assembled center stud (5, fig. 62) and shell (1) from the filter base (2); remove both assemblies and both gaskets (6) from the filter base.
- (5) Remove both filter elements (10) from the shells (1).
- (6) Remove the retaining ring (17) from each center stud (5); remove the element retainer (11), stud gasket (12), stud washer (16), and spring (13) from each center stud.
- (7) Remove the center stud (5) and stud gasket (15) from each shell (1).
- (8) Remove the valve plug (4) from the filter base (2); remove the valve-plug gasket (7), valve spring (8), and bypass valve (9) from the filter base.

*c. Cleaning and Inspection.*

- (1) Discard the filter element. Clean all metallic parts with an approved sol-

vent; dry thoroughly.

- (2) Inspect the filter for cracks, stripped threads, or other damage.
- (3) Inspect the hoses for cracks, deterioration, or other damage.
- (4) Replace the filter elements, all gaskets, and unserviceable parts.

*d. Reassembly and Installation.*

- (1) Install the bypass valve (9) and valve spring (8) into the filter base (2); position the valve-plug gasket (7) on the valve plug (4) and install the valve plug.
- (2) Install a stud gasket (15) and a center stud (5) on each shell (1).
- (3) Install a spring (13), stud washer (16), stud gasket (12), and element retainer (11) on each center stud (5); secure each with a retaining ring (17).
- (4) Install each assembled center stud (5) and shell (1) into the filter base (2); tighten each stud to 50 plus or minus 5 foot-pounds torque.
- (5) Install the pipe plugs (14) into each section of the filter.
- (6) Install the filter and filter mounting bracket (18, fig. 63) on the loader with four capscrews (14), lockwashers (16), nuts (17), and two flat washers (15).
- (7) Install the adapters (3) into the filter inlet and outlet ports. Connect the upper tubes (1 and 2) between the adapters and lower tubes (4 and 9).
- (8) Install the gaskets (6, fig. 62) into the base (2). Install a filter element (10) into each shell (1).
- (9) Service the engine lubrication system.

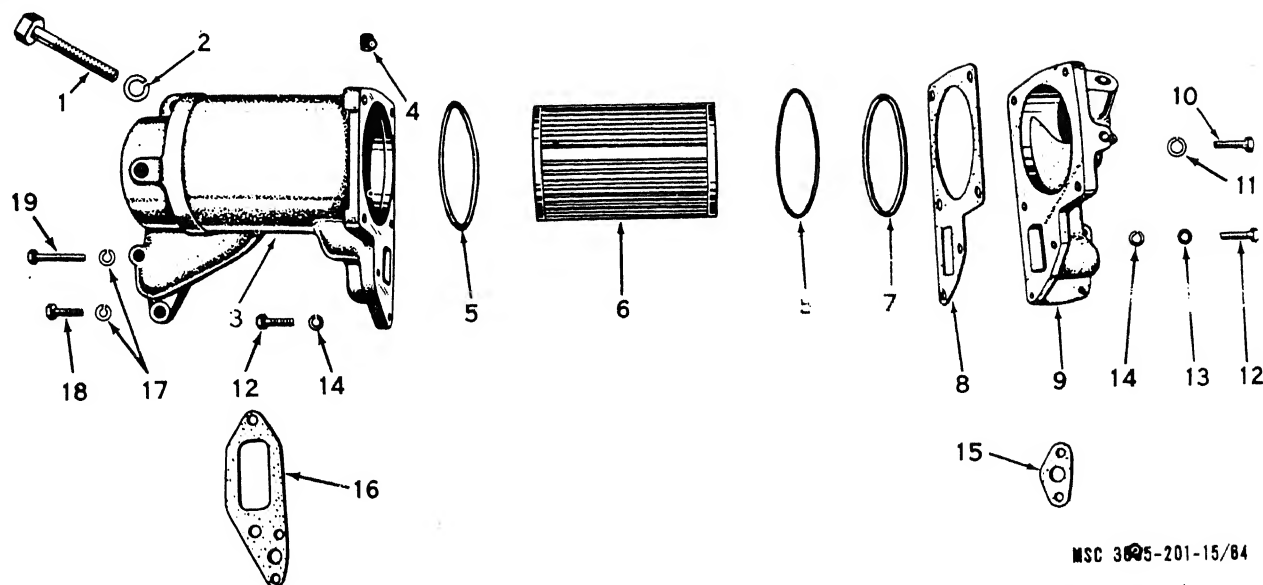
## **156. Engine Oil Cooler** (fig. 64)

*a. Removal.*

- (1) Drain the cooling system as directed in paragraph 148b.
- (2) Remove the screws (1, 18, and 19) and lockwashers (2 and 17) that secure the oil cooler to the cylinder block; remove the oil cooler and the gaskets (15 and 16).

*b. Disassembly.*

- (1) Remove the six screws (10 and 12), lockwashers (11 and 14), and the two washers (13) that secure the oil cooler



MSC 305-201-15/84

- 1 Screw
- 2 Lockwasher
- 3 Oil cooler housing
- 4 Plug
- 5 Preformed packing
- 6 Oil cooler element

- 7 Preformed packing retainer
- 8 Oil cooler cover gasket
- 9 Oil cooler cover

- 10 Screw
- 11 Lockwasher
- 12 Screw
- 13 Washer
- 14 Lockwasher

- 15 Gasket (front)
- 16 Gasket (rear)
- 17 Lockwasher
- 18 Screw
- 19 Screw

Figure 64. Oil cooler, exploded view.

cover (9) to the oil cooler housing (3); remove the oil cooler cover and the gasket (8).

- (2) Remove the preformed packing retainer (7) and the preformed packing (5) from the oil cooler.
- (3) Install two 10-32 screws into the tapped holes of the oil cooler element (6); pull the element from the oil cooler housing.
- (4) Remove the remaining preformed packing (5) and the plug (4) from the oil cooler housing.

#### c. Cleaning and Inspection.

- (1) Clean the oil cooler housing and the cover with an approved cleaning solvent.

**Caution:** Do not scrape the element or use a solvent that is harmful to copper.

- (2) Immerse the element in solvent that will dissolve oil film and sludge. Check to be sure that the water passages are not obstructed or corroded.
- (3) Inspect the parts for cracks, breaks, or damage that might cause leakage.
- (4) Replace the gaskets, preformed pack-

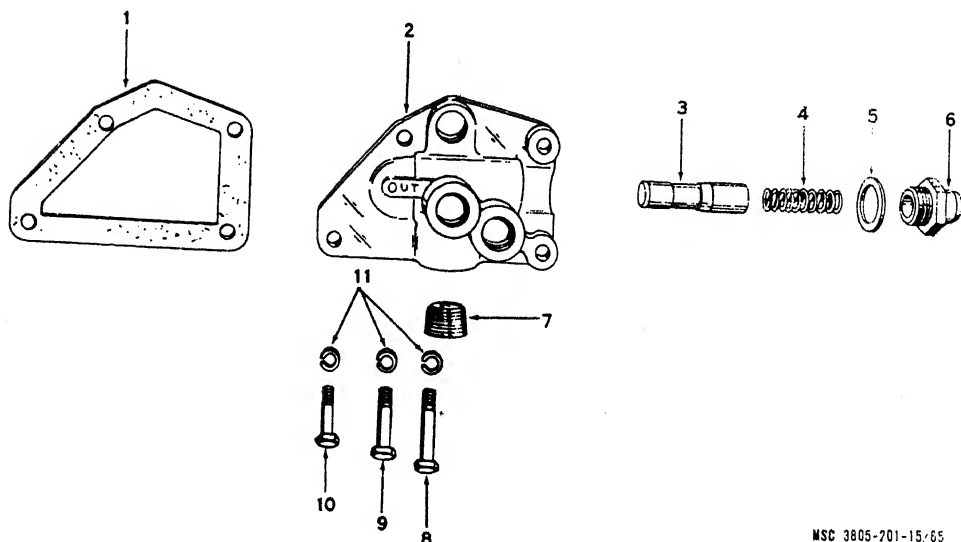
ings, and any parts that are damaged or defective.

#### d. Reassembly.

- (1) Apply a coating of bearing grease on the preformed packings (5). Position one preformed packing in the bottom of the oil cooler housing (3); install the plug (4) on the oil cooler housing.
- (2) Align the index markings of the oil cooler housing and the element; push the element into place.
- (3) Position the second preformed packing and the preformed packing retainer (7) on the oil cooler housing.
- (4) Position the gasket (8) and the oil cooler cover (9) on the oil cooler housing; secure with the four screws (10), lockwashers (11), two screws (12), lockwashers (14), and washers (13).

#### e. Installation.

- (1) Position a new preformed packing on the oil cooler connection.
- (2) Position the gaskets (15 and 16) and the assembled oil cooler on the cylinder block; secure with the four screws (1, 18, and 19) and lockwasher (2 and 17).



1 Gasket	4 Spring	7 Plug	10 Capscrew
2 Body	5 Gasket	8 Capscrew	11 Lockwasher
3 Plunger	6 Retainer cap	9 Capscrew	

Figure 65. Pressure relief valve, exploded view.

- (3) Fill the cooling system as directed in paragraph 148a.

## 157. Pressure Relief Valve

### a. Removal and Disassembly.

- (1) Drain the lubrication system and disconnect the two lower tubes (4 and 9, fig. 63) from the upper tubes (1 and 2) and from the pressure relief valve body. Remove the adapters from the body.
- (2) Remove the four capscrews (8 and 10, fig. 65) and lockwashers (11) that secure the pressure relief valve to the engine; remove the pressure relief valve and gasket (1).
- (3) Remove the retainer cap (6) and gasket (5) from the relief valve body (2); remove the spring (4) and plunger (3) from the body.

### b. Cleaning and Inspection.

- (1) Discard the gaskets. Clean all remaining parts with an approved cleaning solvent; dry thoroughly.
- (2) Inspect the relief valve body for cracks, damaged threads, scored and worn plunger passages, or other damage; replace a damaged body.
- (3) Inspect the plungers for wear or scoring; replace damaged plungers.
- (4) Inspect the relief valve spring for

loss of tension; replace if weak or deformed.

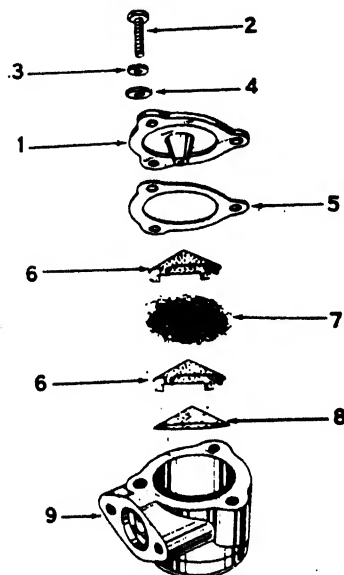
- (5) Inspect all other parts for cracks, worn or damaged threads, distortion, or other damage; replace damaged parts.

c. Reassembly and Installation. Reassemble and install the pressure relief valve by reversing the removal and disassembly procedure described in a above.

## 158. Crankcase Breather

### a. Removal and Disassembly.

- (1) Remove the screw and lockwasher that secure the ventilation tube clamp (11, fig. 71) to the engine; remove the clamp.
- (2) Remove the two screws (6) and lockwashers (7) that secure the ventilation tube (10) to the crankcase breather (5); remove the ventilation tube and the preformed packing (8).
- (3) Remove the crankcase breather from the cylinder head cover.
- (4) Remove the three screws (2, fig. 66), lockwashers (3), and washers (4) that secure the crankcase breather cover (1) to the body (9); remove the cover, gasket (5), screen (6), element (7), and baffle (8).



MSC 3805-201-15/88

- |              |                 |
|--------------|-----------------|
| 1 Cover      | 6 Screen        |
| 2 Screw      | 7 Element       |
| 3 Lockwasher | 8 Baffle        |
| 4 Washer     | 9 Breather body |
| 5 Gasket     |                 |

Figure 66. Crankcase breather, exploded view.

**b. Cleaning and Inspection.**

- (1) Wash all of the parts thoroughly with an approved cleaning solvent.
- (2) Check to be sure there are no kinks or obstructions in the ventilation tube.
- (3) Inspect the parts for cracks, deterioration, or damage.
- (4) Replace the gasket, preformed packing, and all defective parts.

**c. Reassembly and Installation.** Reassemble and install the crankcase breather by reversing the removal and disassembly procedure described in *a* above.

## 159. Engine Lubricating Oil Lines

**a. Removal and Disassembly.**

- (1) Remove the cap screw (8, fig. 63), lockwasher, and nut that secure the tube clamp (5) to the bracket (6).
- (2) Loosen the four tube nuts that secure the lower tubes (4 and 9) to the adapters on the pressure relief valve body and to the upper tubes (1 and 2); remove the lower tubes.
- (3) Loosen the two tube nuts that secure the upper tubes (1 and 2) to the adapters on the filter; remove the upper tubes.

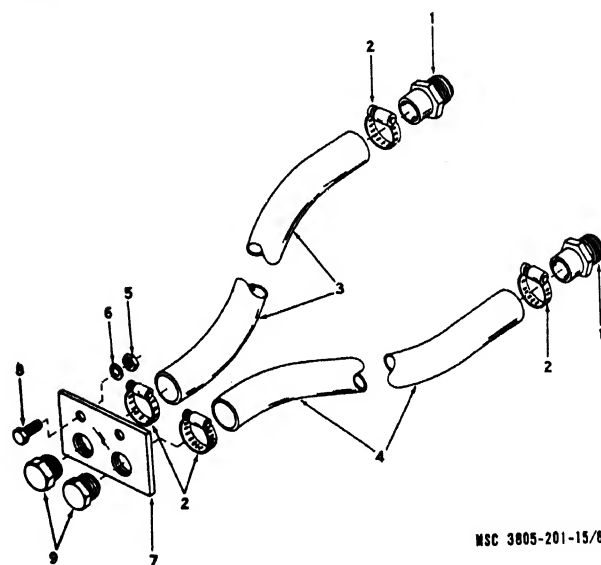
(4) Loosen the hose clamps (2, fig. 67) that secure the hoses (3 and 4) to the nipples (1) on the engine oil pans and on the oil drain (7); remove the hoses. Remove the nipples from the engine oil pans.

(5) Remove the two cap screws (8), nuts (5), and lockwashers (6) that secure the oil drain to the loader frame; remove the oil drain.

**b. Cleaning and Inspection.**

- (1) Wipe the hoses with a clean, dry cloth.
- (2) Clean all other parts with an approved cleaning solvent; dry thoroughly.
- (3) Inspect the hoses for cracks, deterioration, or other damage; replace a damaged hose.
- (4) Inspect all other parts for cracks, worn or damaged threads, and distortion; replace damaged parts.

**c. Reassembly and Installation.** Reassemble and install the engine lubricating hoses by reversing the removal and disassembly procedure given in subpara. graph *a* above. Be sure to connect the OUT port of the pressure relief valve with the IN port of the filter and connect the OUT port of the filter with the IN port of the pressure relief valve.

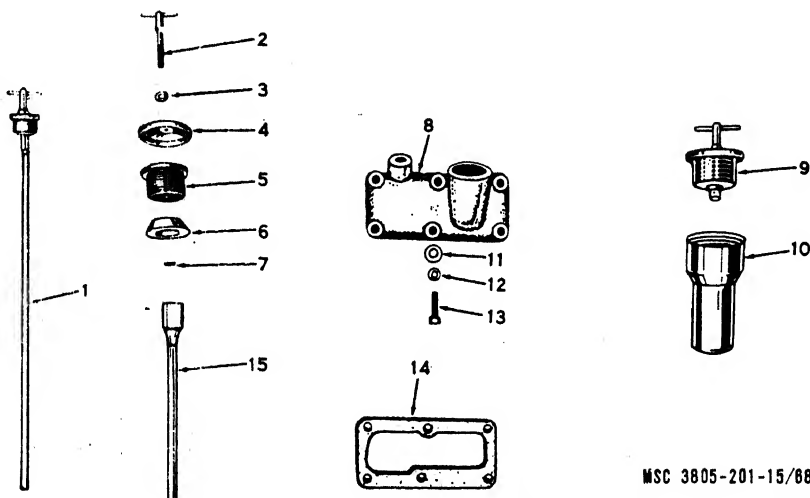


MSC 3805-201-15/87

- |              |              |
|--------------|--------------|
| 1 Nipple     | 6 Lockwasher |
| 2 Hose clamp | 7 Oil drain  |
| 3 Hose       | 8 Cap screw  |
| 4 Hose       | 9 Drain plug |
| 5 Nut        |              |

Figure 67. Engine oil drain lines, exploded view.





MSC 3805-201-15/88

- |                  |                      |                   |                  |
|------------------|----------------------|-------------------|------------------|
| 1 Oil level gage | 5 Bushing            | 9 Filler tube cap | 13 Capscrew      |
| 2 Handle         | 6 Cone               | 10 Filler tube    | 14 Gasket        |
| 3 Washer         | 7 Pin                | 11 Flat washer    | 15 Oil gage tube |
| 4 Cover          | 8 Oil filter bracket | 12 Lockwasher     |                  |

Figure 68. Oil level gage, filler tube, and bracket, exploded view.

## 160. Oil Level Gage, Filler Tube, and Bracket (fig. 68)

### a. Removal.

- (1) Remove the assembled oil level gage (1) from the oil gage tube (15) on the oil filler bracket (8). Remove the filler tube cap (9) from the filler tube (10).
- (2) Remove the six capscrews (13), lockwashers (12), and flat washers (11) that secure the oil filler bracket (8) to the engine oil pan; remove the bracket and gasket (14).
- (3) Remove the filler tube (10) and oil gage tube (15) from the bracket.
- (4) Drive out the pin (7) and disassemble the cone (6), bushing (5), cover (4), washer (3), and handle (2) from the oil level gage.

### b. Cleaning and Inspection.

- (1) Discard the gasket. Clean all other parts with an approved cleaning solvent; dry thoroughly.
- (2) Inspect the oil filler bracket, the filler tube, and oil gage tube for cracks, distortion, worn or damaged threads, or other damage; replace damaged parts.
- (3) Inspect the oil level gage for distortion. Make sure the markings are legible. Replace if damaged.
- (4) Inspect all other parts for cracks, distortion, worn or damaged threads, or other damage; replace damaged parts.

c. *Installation.* Install the oil level gage, filler tube, and bracket by reversing the removal procedure given in *a* above.

## Section IX. ENGINE

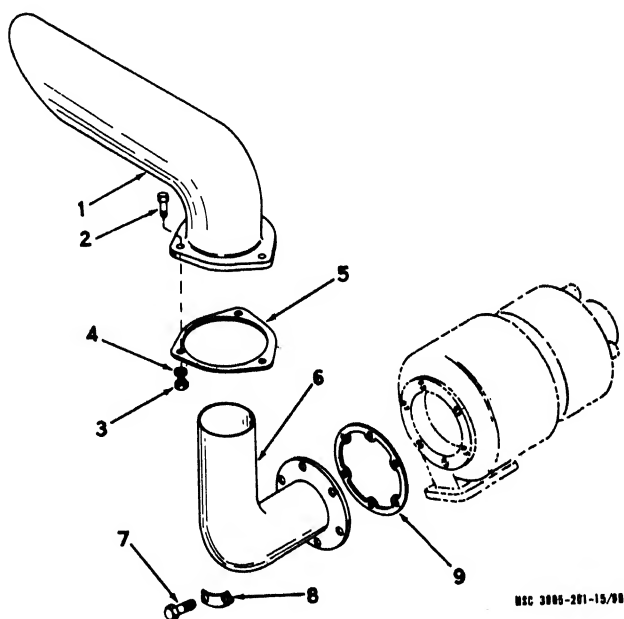
### 161. General

a. The turbocharged diesel engine is mounted on the loader frame at the rear of the loader. It is housed by the hood and side panels of the loader. A port is provided in the hood for the exhaust pipe from the turbocharger.

b. The turbocharger is driven by exhaust gases and acts as a compressor to force fresh air into the intake manifold to increase the

amount of fuel that can be burned by the engine. By increasing the amount of fuel burned, the output horsepower is greatly increased over that possible by a naturally aspirated engine. The turbocharger requires routine maintenance as described in paragraph 163.

c. Access to the injectors and valves for routine adjustment is made by removing the rocker arm cover. Injector and valve adjustments must



- |                |                 |
|----------------|-----------------|
| 1 Exhaust pipe | 6 Exhaust elbow |
| 2 Screw        | 7 Screw         |
| 3 Nut          | 8 Lockplate     |
| 4 Lockwasher   | 9 Gasket        |
| 5 Gasket       |                 |

Figure 69. Exhaust pipe and fittings, exploded view.

be checked after every 600 hours of engine operation. Valves may be adjusted only after adjustment of the injectors.

d. The exhaust manifolds are located on the engine on the left side of the loader. The intake manifolds are located on the engine on the right side of the loader.

## 162. Exhaust Pipe and Fittings (fig. 69)

### a. Removal and Disassembly.

- (1) Remove the large left side panel from the loader.
- (2) Remove the three screws (2), nuts (3), and lockwashers (4) that secure the exhaust pipe and gasket (5).
- (3) Remove the six screws (7) and three lockplates (8) that secure the exhaust elbow (6) to the turbocharger; remove the exhaust elbow and gasket (9).

### b. Cleaning and Inspection.

- (1) Clean all rust and scale from the parts, using a wire brush.
- (2) Scrape all carbon from the parts.
- (3) Inspect the parts for cracks or excessive corrosion.
- (4) Replace unserviceable parts.

c. *Reassembly and Installation.* Reassemble and install the exhaust pipe and fittings by reversing the removal and disassembly information given in a above.

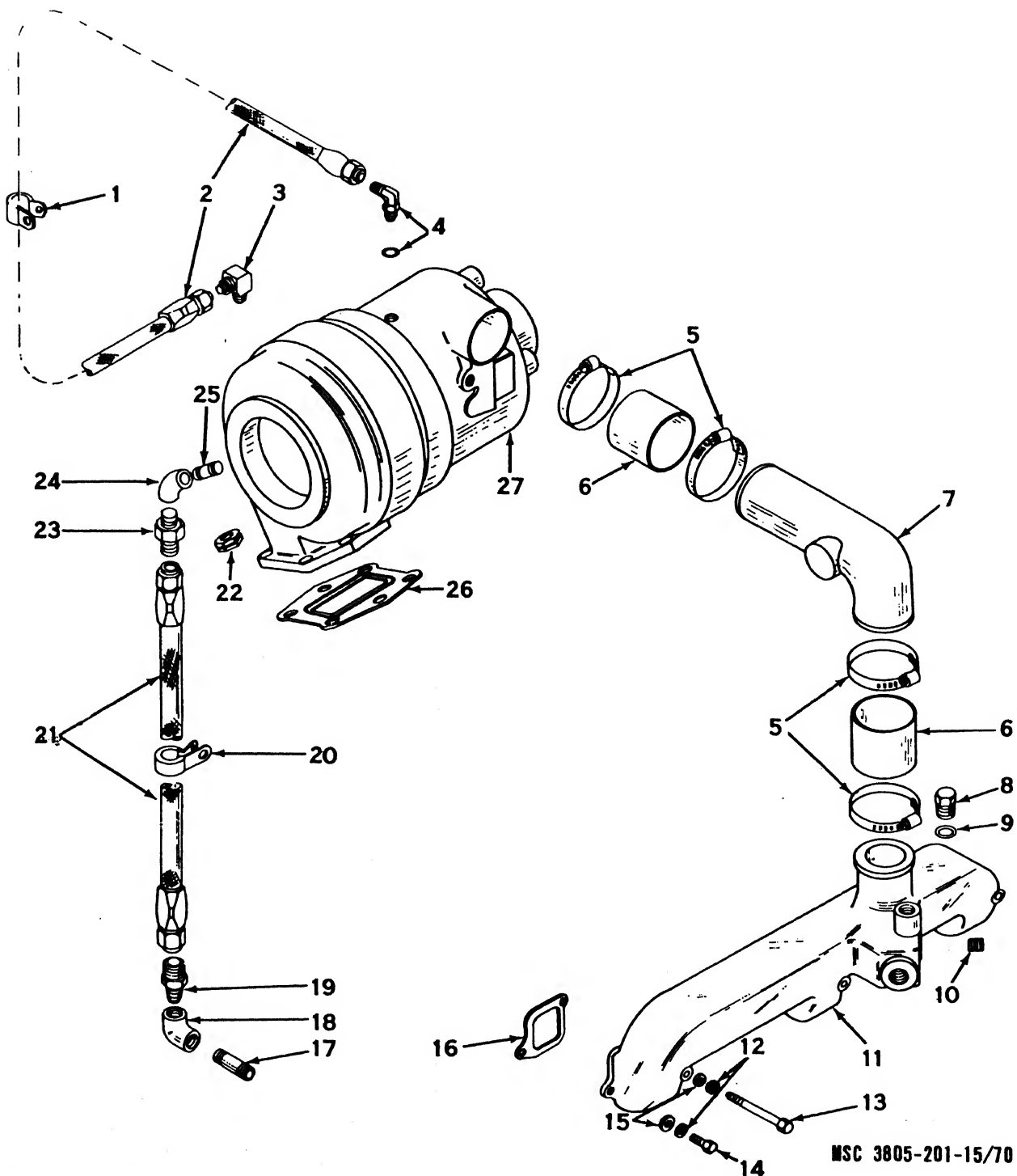
## 163. Turbocharger (fig. 70)

a. *Checking Bearing Clearance.* Every 800 hours, check the bearing clearance of the turbocharger as follows:

- (1) Remove the air inlet tubing as directed in paragraph 128b.
- (2) Remove the exhaust pipe and exhaust elbow as directed in paragraph 162a.
- (3) Fasten a dial indicator to the turbine casing on the exhaust side of the turbocharger with the point of the indicator against the hub of the turbine wheel.
- (4) Move the turbine wheel up and down, or sideways, and note the indicator reading. The total indicator reading should not exceed 0.010 inch.
- (5) Remove one of the capscrews from the front plate on the compressor end of the turbocharger and replace it with a longer capscrew of the same thread size. Attach the indicator to the capscrew so that the point is against the flat on the end of the rotor shaft.
- (6) Move the shaft up and down, or sideways, to determine the total play. The indicator reading should not exceed 0.010 inch.
- (7) Reposition the indicator so that the point is against the end of the rotor shaft. Check for the end play of the shaft. Total indicator reading should be between 0.004 and 0.010 inch.
- (8) If radial play or end play is not within the tolerances indicated, replace the turbocharger.

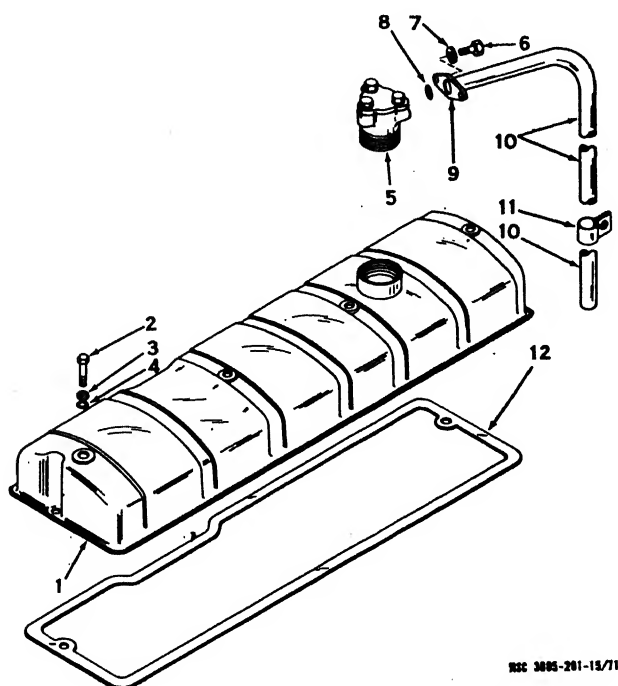
b. *Servicing.* Every 1600 hours, clean the compressor wheel of the turbocharger to insure best turbocharger performance. Dirt on the compressor wheel will choke off air flow and cause rotor unbalance. Clean the compressor wheel as follows:

- (1) Remove the air inlet tubing as directed in paragraph 128b.
- (2) Remove the eight capscrews, lockwashers, and plain washers that secure the front plate to the turbo-



- |                         |                    |                    |                   |
|-------------------------|--------------------|--------------------|-------------------|
| 1 Clip                  | 8 Plug             | 15 Flat washer     | 21 Oil drain hose |
| 2 Oil supply hose       | 9 Gasket           | 16 Intake manifold | 22 Locknut        |
| 3 Elbow                 | 10 Plug            | 17 Nipple          | 23 Adapter        |
| 4 Connection            | 11 Intake manifold | 18 Elbow           | 24 Coupling       |
| 5 Hose clamp            | 12 Lockwasher      | 19 Adapter         | 25 Nipple         |
| 6 Hose                  | 13 Screw           | 20 Clamp           | 26 Gasket         |
| 7 Air intake connection | 14 Screw           |                    | 27 Turbocharger   |

Figure 70. Intake manifold and turbocharger connections, exploded view.



- |                               |                     |
|-------------------------------|---------------------|
| 1 Cylinder head cover         | 7 Lockwasher        |
| 2 Screw                       | 8 Preformed packing |
| 3 Washer                      | 9 Flange            |
| 4 Preformed packing           | 10 Tube             |
| 5 Crankcase breather assembly | 11 Clamp            |
| 6 Screw                       | 12 Gasket           |

Figure 71. Cylinder head cover, exploded view.

charger; remove the front plate to expose the compressor wheel.

- (3) Use an approved cleaning solvent and a nylon or hog bristle brush to clean the compressor wheel. If the compressor wheel cannot be cleaned in this manner, replace the turbocharger. Dry the compressor wheel with clean compressed air.

**Caution:** Do not use caustic solutions or any other types of solvents that attack aluminum. Never use a wire brush or scraper to remove the dirt from the compressor wheel. Failure to follow these instructions will result in rotor unbalance and premature failure of the turbocharger.

- (4) Install the front plate on the turbocharger and install the air inlet tube as described in paragraph 128b.

#### c. Removal.

- (1) Remove the exhaust pipe as directed in paragraph 162a.

- (2) Loosen the hose clamps (5) that secure the hoses (6) to the turbocharger air outlet and the intake manifold (11); remove the assembled hoses and air intake connection from the turbocharger and the intake manifold.
- (3) Remove the two hoses (6) and the hose clamps (5) from the air intake connection (7).
- (4) Remove the air inlet tubing as directed in paragraph 128b.
- (5) Remove the screws and lockwashers that secure the hose clamp (20) and the clip (1); remove the hose clamp and the clip.
- (6) Disconnect the oil drain hose (21) from the adapters (23 and 19); remove the oil drain hose, adapter, coupling (24), and nipples (17 and 25).
- (7) Disconnect the oil supply hose (2) from the connection (4) and the elbow (3) on the oil cooler; remove the oil supply hose, the connections, and the elbow.
- (8) Remove the six locknuts (22) that secure the turbocharger (27) to the exhaust manifold; remove the turbocharger and gasket (26).

#### d. Cleaning and Inspection.

- (1) Wipe all grease and dirt from the exterior of the turbocharger with a cloth dampened with an approved cleaning solvent.
- (2) Inspect the turbocharger for cracks, binding, or improper operation; repair or replace the turbocharger if defective.
- (3) Examine the hoses for cracks, deterioration, or damage.
- (4) Replace the gasket and all damaged or defective fittings or parts.

#### e. Installation.

- (1) Position the gasket (26) and the assembled turbocharger (27) on the exhaust manifold; secure with the six locknuts (22).
- (2) Install the nipple (17), elbow (18), and adapter (19) on the oil pan, and the nipple (25), coupling (24), and adapter (23) on the turbocharger; connect the oil drain hose (21).

- (3) Install the elbow (3) on the oil cooler and the connection (4) on the turbocharger; connect the oil supply hose (2) to the connection and the elbow.
- (4) Position the hose clamp (20) on the oil drain hose (21), and the clip (1) on the oil supply hose; secure each with a screw and lockwasher.
- (5) Position the two hoses (6) on the air intake connection (7); slide two hose clamps (5) over each of the hoses.
- (6) Position the hoses on the turbocharger air outlet and the intake manifold (11); tighten the four hose clamps.
- (7) Install the air inlet tube as directed in paragraph 128d.
- (8) Install the exhaust pipe as directed in paragraph 162c.

#### 164. Cylinder Head Cover (fig. 71)

##### a. Removal.

- (1) Remove and service the crankcase breather assembly (5) as directed in paragraph 158a and b.
- (2) Remove the four screws (2), washers (3), and preformed packing (4) that secure the cylinder head cover (1) to the cylinder head; remove the cylinder head cover and the gasket (12).

##### b. Cleaning and Inspection.

- (1) Clean all dirt and grease from the cylinder head cover with an approved cleaning solvent; remove any particles of old gaskets.
- (2) Inspect the cylinder head cover for cracks, dents, or distortion.

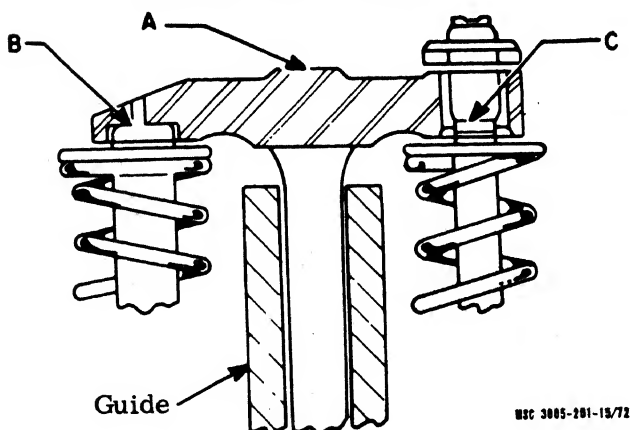


Figure 72. Alinement of crosshead stem and guide.

- (3) Replace the gasket and any damaged or unserviceable parts.

##### c. Installation.

- (1) Position the gasket (12) and the cylinder head cover (1) on the engine cylinder head; secure with the four screws (2), washers (3), and preformed packing (4).
- (2) Install the crankcase breather assembly (5) as directed in paragraph 158c.

#### 165. Valve Adjustment

*Note.* Adjust the injector plunger for each cylinder before adjusting the valves for that cylinder.

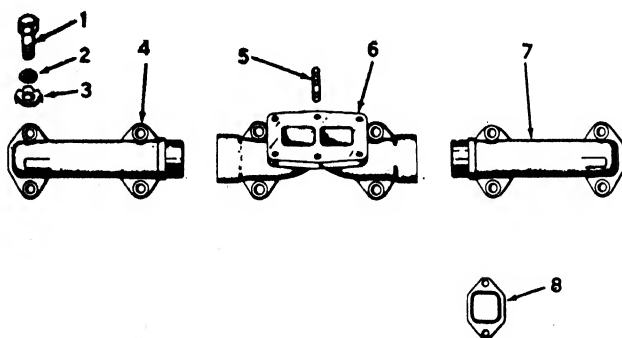
a. Perform (1) through (5) as directed in paragraph 134c.

b. Loosen the locknut and back off the rocker lever adjustment screw.

c. Adjust the crossheads (fig. 72):

- (1) Use a light finger pressure at rocker lever contact surface A to hold the crosshead against valve stem B that is nearer the push rod.
- (2) Loosen the locknut and turn the adjusting screw down until it contacts its mating valve stem C.
- (3) When adjusting new crossheads and guides, advance the adjusting screw 20° (one-third of one hex) to straighten the crosshead stem in its guide and to compensate for slack in the threads.

d. Insert a feeler gage between the rocker lever and the top of the crosshead. The feeler gage for intake valves should be 0.015 inch



- |                         |                            |
|-------------------------|----------------------------|
| 1 Screw                 | 6. Center exhaust manifold |
| 2 Washer                | 7 Front exhaust manifold   |
| 3 Lockplate             | 8 Gasket                   |
| 4 Rear exhaust manifold |                            |
| 5 Stud                  |                            |

Figure 73. Exhaust manifolds, exploded view.

thick; for exhaust valves, it should be 0.025 inch thick.

e. Turn the adjusting screw down until the rocker lever just touches the feeler gage.

f. Lock the adjusting screw by tightening the locknut.

g. Continue the above procedure for each cylinder in firing order, after the injector for that cylinder has been adjusted. The firing order is 1-5-3-6-2-4.

## 166. Exhaust Manifolds (fig. 73)

### a. Removal.

(1) Remove the turbocharger as directed in paragraph 163c.

(2) Bend down the tabs of the lockplates (3). Remove the 12 screws (1), washers (2), and lockplates that secure the exhaust manifolds to the cylinder head; remove the manifolds and the six gaskets (8).

(3) Remove the front exhaust manifold (7) and the rear exhaust manifold (4) from the center exhaust manifold (6)

### b. Cleaning and Inspection.

(1) Clean all carbon, dirt, and fragments of old gaskets from the exhaust manifolds.

(2) Replace the lockplates and any damaged hardware or parts.

### c. Installation.

(1) Position the front exhaust manifold (7) and the rear exhaust manifold (4) on the center exhaust manifold (6).

(2) Position the exhaust manifolds and the six gaskets (8) on cylinder head;

secure with 12 screws (1), lockplates (3), and washers (2). Tighten the screws alternately to 25 foot-pounds torque; bend the lockplates to lock in place.

(3) Install the turbocharger as directed in paragraph 163e.

## 167. Intake Manifold

### a. Removal.

(1) Remove the air intake connection as directed in paragraph 163c(2).

(2) Disconnect the primer discharger line (7, fig. 35) from the nozzle; remove the primer discharger nozzle and connector from the intake manifold (11, fig. 70).

(3) Disconnect the manifold-to-aneroid hose (6) from the intake manifold. Remove the six screws (13 and 14), lockwashers (12), and flat washers (15) that secure the intake manifold (11) to the cylinder head; remove the intake manifold and the three gaskets (16).

(4) Remove the plug (8), gasket (9), and the plug (10) from the intake manifold.

### b. Cleaning and Inspection.

(1) Clean all dirt, carbon, and corrosion from the intake manifold.

(2) Inspect the intake manifold for cracks, distortion, or damage.

(3) Replace the intake manifold gaskets and all unserviceable parts.

c. Installation. Install the intake manifold by reversing the removal procedure described in a above.

## Section X. CONTROLS AND INSTRUMENTS

### 168. Foot Throttle Pedal and Linkage

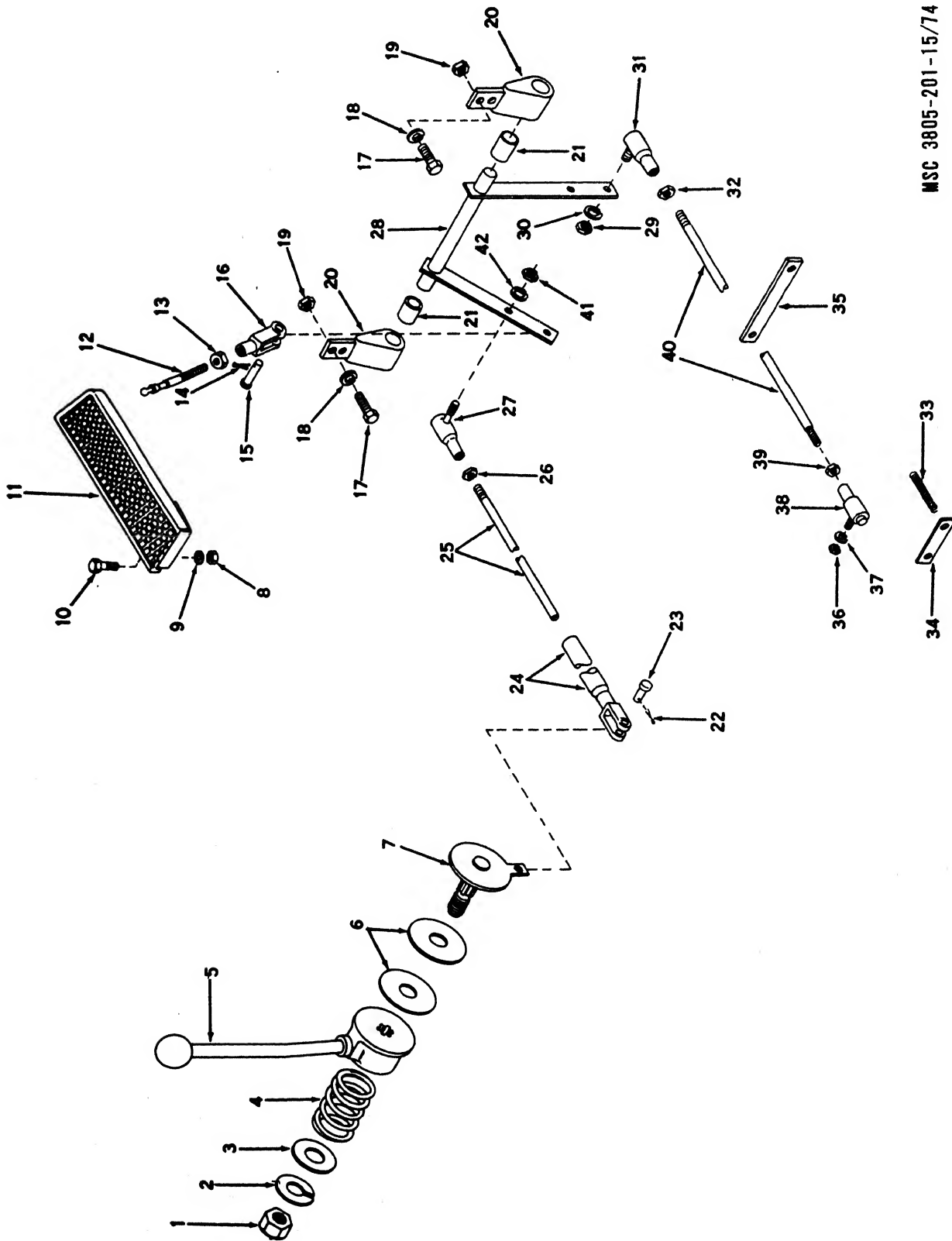
a. Adjustment (fig. 74). Adjustment of the foot throttle pedal and linkage should provide a condition that enables the operator to move the throttle lever on the fuel pump through its full operating range without excessive play, by depressing the operating lever fully from its normal position. The adjustment should also provide a comfortable pedal angle for the operator. Adjust the accelerator rod first; then adjust the accelerator pedal setting.

#### (1) Accelerator rod.

(a) Loosen the locking nut (39) that secures the accelerator rod (40) to the ball joint (38).

(b) Remove the hex nut (36) and lockwasher (37) that secure the ball joint (38) to the throttle lever on the fuel pump; disconnect the ball joint from the lever.

(c) Screw the ball joint clockwise to shorten the accelerator rod and to



MSC 3805-201-15/74

Figure 74. Hand and foot throttle linkage, exploded view.

1 Hex nut  
2 Lockwasher  
3 Flat washer  
4 Spring  
5 Hand throttle lever  
6 Friction disk  
7 Throttle shaft  
8 Hex nut  
9 Lockwasher  
10 Capscrew  
11 Accelerator pedal

12 Pedal rod  
13 Locking nut  
14 Cotter pin  
15 Clevis pin  
16 Adjustable yoke end  
17 Capscrew  
18 Lockwasher  
19 Hex nut  
20 Bellcrank bearing  
21 Bushing  
22 Cotter pin

23 Clevis pin  
24 Tube and yoke assembly  
25 Push rod  
26 Locking nut  
27 Ball joint  
28 Bellcrank  
29 Hex nut  
30 Lockwasher  
31 Ball joint  
32 Locking nut

33 Throttle return spring  
34 Spring clip  
35 Accelerator rod support  
36 Hex nut  
37 Lockwasher  
38 Ball joint  
39 Locking nut  
40 Accelerator rod  
41 Hex nut  
42 Lockwasher

Figure 74—Continued.

raise the toe end of the accelerator pedal (11). Screw the ball joint counterclockwise to lengthen the accelerator rod and to lower the toe end of the accelerator pedal.

- (d) When the adjustment is completed, tighten the locking nut (39) against the ball joint (38). Secure the ball joint to the throttle lever with the hex nut (36) and lockwasher (37).

(2) *Accelerator pedal.*

- (a) Pull the toe of the accelerator pedal (11) upward so that it disengages from the pedal rod (12).

- (b) Using an open end wrench, loosen the locking nut (13) that secures the pedal rod to the adjustable yoke end (16). To lower the toe end of the accelerator pedal, turn the pedal rod clockwise; to raise the toe end, turn the rod counterclockwise.

- (c) When the adjustment is completed, tighten the locking nut (13) against the adjustable yoke end (16). Insert the upper end of the pedal rod (12) into the hole in the bottom side of the accelerator pedal (11).

b. *Removal.*

- (1) Remove the rear floorboard as directed in paragraph 181a.
- (2) Remove the hex nut (41) and lockwasher (42) that secure the ball joint (27) to the bellcrank (28).
- (3) Loosen the locking nut (13) that secures the pedal rod (12) to the adjustable yoke end (16); remove the pedal rod from the yoke end and remove the locking nut from the rod.
- (4) Remove the cotter pin (14) and clevis pin (15) that secure the adjustable yoke end (16) to the bellcrank; remove the yoke end.

- (5) Disengage and remove the throttle return spring (33).

- (6) Remove the capscrew, hex nut, flat washer, and lockwasher that secure the accelerator rod support (35) to the compressor air governor.

- (7) Remove the hex nut (29) and lockwasher (30) that secure the ball joint (31) to the bellcrank (28); disconnect the ball joint from the cross shaft.

- (8) Remove the hex nut (36) and lockwasher (37) that secure the ball joint (38) to the throttle lever; disconnect the ball joint from the throttle lever.

- (9) Remove the assembled accelerator rod, accelerator rod support and ball joints from the loader.

- (10) Loosen the locking nuts (32 and 39) that secure the ball joints (31 and 38) to the accelerator rod (40); remove the ball joints and the accelerator rod support (35).

- (11) Remove the capscrews (17), lockwashers (18), and hex nuts (19) that secure the bellcrank bearings (20) to the loader frame; remove the assembled bellcrank (28) and bearings. Slip the bellcrank bearings (20) from the bellcrank.

- (12) Remove the two capscrews (10), lockwashers (9), and hex nuts (8) that secure the accelerator pedal (11) to the front floorboard; remove the pedal.

c. *Cleaning and Inspection.*

- (1) Clean all parts with an approved cleaning solvent; dry thoroughly.
- (2) Check all pins, ball joints, and other parts for wear.
- (3) Check all threaded parts for worn or damaged threads.
- (4) Check grease fittings for clogging, cracks, and other damage.
- (5) Check all metal parts for rust and



other corrosion. If necessary, clean with a wire brush and repaint.

- (6) Replace all unserviceable parts.

*d. Installation.*

- (1) Install the foot throttle and linkage by reversing the removal procedure given in *b* above. Refer to figure 74.
- (2) Adjust the foot throttle linkage as directed in *a* above.
- (3) Position the ball joint (27) on the bellcrank (28); secure with a hex nut (41) and lockwasher (42).
- (4) Install the rear floorboard as directed in paragraph 181c.

### 169. Hand Throttle (fig. 74)

*a. Adjustment.* The hand throttle linkage must be adjusted so that when the hand throttle is in the idle position against its stop, the throttle lever on the fuel pump is in the idle position against the throttle lever stop screw. Excessive play should not exist before the hand throttle lever starts to move the linkage. Adjust as follows:

- (1) If the fuel pump throttle lever is not fully against the throttle lever stop when the hand throttle lever is in the idle position against its stop, the push rod (25) should be turned farther into the ball joint (27) to shorten the linkage. Loosen the locking nut (26) and turn the push rod clockwise to shorten the linkage. Tighten the locking nut to secure the adjustment.
- (2) If the hand throttle lever must be moved an excessive distance before the linkage moves, the push rod (25) should be turned farther out of the ball joint (27) to lengthen the linkage. Loosen the locking nut (26) and turn the push rod counterclockwise to lengthen the linkage. Tighten the locking nut to secure the adjustment.

*b. Removal.*

- (1) Remove the rear floorboard as directed in paragraph 181a.
- (2) Remove the hex nut (41) and lockwasher (42) that secure the assembled ball joint (27) and push rod (25) to the arm of the bellcrank (28); remove the yoke end and rod from the arm.
- (3) Remove the cotter pin (22) and clevis

pin (23) that hold the tube and yoke assembly to the arm of the throttle shaft; remove the tube and yoke assembly.

- (4) Loosen the locking nut (26) that secures the ball joint (27) to the push rod; disassemble the ball joint from the push rod.
- (5) Remove the hex nut (1), lockwasher (2), and flat washer (3) that secure the hand throttle lever assembly to the frame of the loader. Remove the spring (4), the assembled hand throttle lever (5), two friction disks (6), and throttle shaft (7).

*c. Inspection.*

- (1) Clean all parts with an approved cleaning solvent.
- (2) Inspect all parts for excessive wear, cracks, and breaks. Replace all unserviceable parts.
- (3) Check all threaded parts for worn or damaged threads. Replace if necessary.
- (4) Check all metal parts for rust and other corrosion. Clean all corroded parts with a wire brush and repaint.

*d. Installation.*

- (1) Install the hand throttle lever and linkage by reversing the removal procedure given in *b* above.
- (2) Adjust the linkage as described in *a* above.
- (3) Install the floorboards as directed in paragraph 181c.

### 170. Instrument Panel (fig. 10)

*a. Removal and Disassembly.*

- (1) Remove the four capscrews that secure the instrument panel (31) to the frame; pull the instrument panel from the frame far enough to facilitate removal of the leads.
- (2) Remove the electrical leads from the electrical components. Tag the leads to facilitate reassembly.
- (3) Remove the two nuts and the clamp that secure each of the following instruments to the instrument panel: torque converter oil temperature gage (3), air pressure gage (4), transmis-

sion clutch oil pressure gage (5), engine temperature gage (7), hourmeter (6), ammeter (9), and engine oil pressure gage (8). Remove the instruments from the front of the panel.

- (4) Remove the two machine screws that secure the torque converter temperature warning lamp (34) and the panel lamps to the instrument panel; remove the lamps from the front of the panel.
- (5) Remove the four grommets from the mounting holes of the instrument panel.
- (6) Do not remove the identification plates from the panel unless they or the panel are damaged and require replacement.

*b. Cleaning and Inspection.*

- (1) Clean the instrument panel and the instruments with a cloth lightly dampened with an approved cleaning solvent; dry thoroughly.
- (2) Inspect the instruments for cracked cases or glass, illegible or discolored dial faces, damaged terminals, failure of the pointer to move to the unoperated position, or other indications of damage or improper operation; replace damaged instruments.
- (3) Inspect the torque converter temperature warning lamp and the panel lamps for cracked lenses, damaged housings, bent or damaged terminals, or other damage; replace damaged lamps.
- (4) Inspect the nameplates on the instrument panel for illegible or defaced markings; touch up or replace damaged nameplates.
- (5) Inspect the instrument panel for cracks, distortion, chipped or worn paint, or other damage. Touch up the paint as required. Replace if otherwise damaged.

*c. Reassembly and Installation.* Reassemble and install the instrument panel by reversing the removal and disassembly procedure given in *a* above.

## **171. Light and Ignition Control Panel**

(fig. 10)

*a. Removal and Disassembly.*

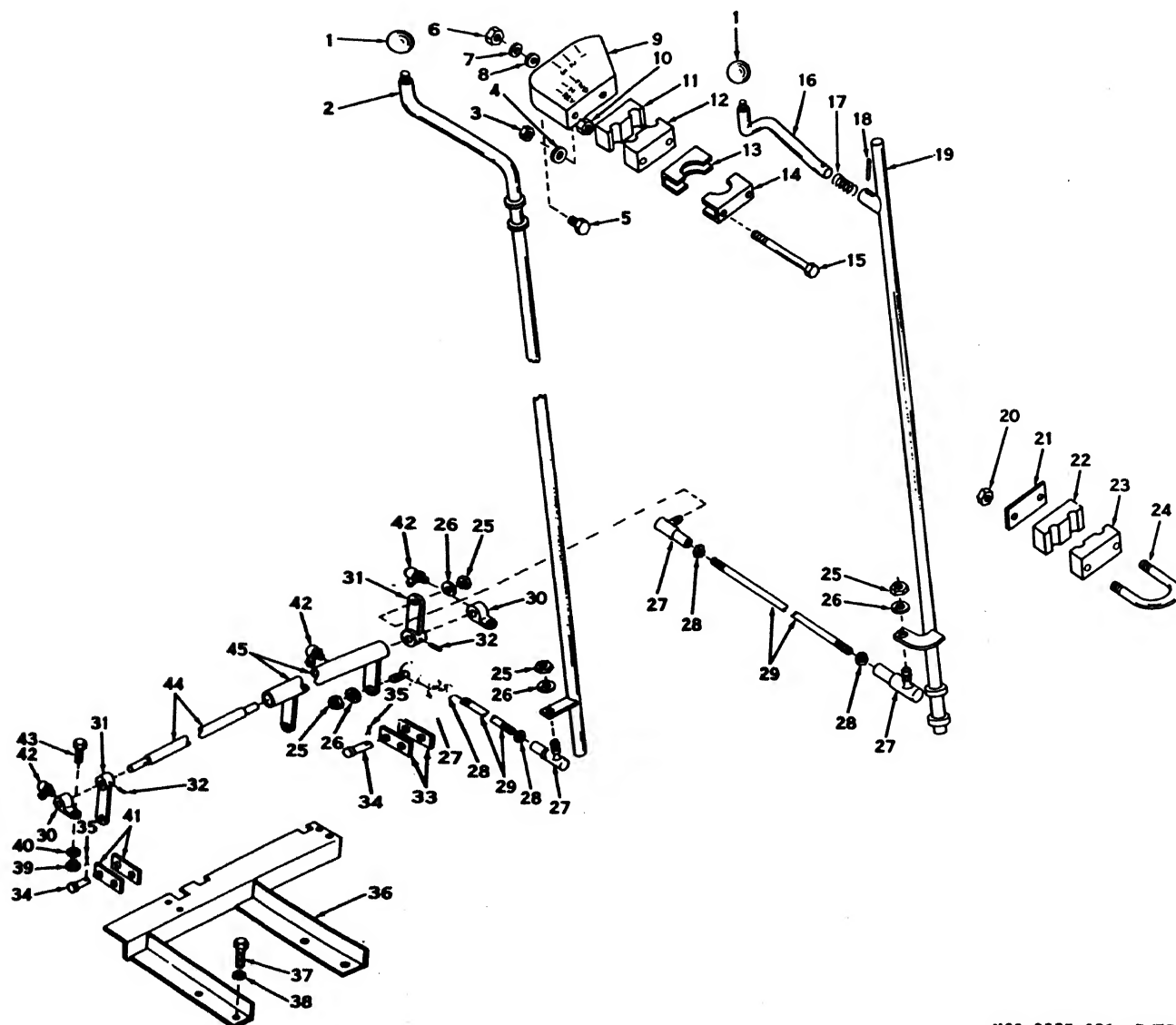
- (1) Remove the capscrews and lockwash-

ers that secure the light and ignition control panel (23) to the frame; pull the panel away from the frame far enough to facilitate removal of the electrical leads.

- (2) Disconnect the electrical leads from the components of the control panel. Tag the leads to facilitate reassembly.
- (3) Remove the machine screws that hold each lever to the light control switch; remove the three levers. Remove the four machine screws that secure the light control switch (28) to the panel; remove the switch.
- (4) Remove the two machine screws that secure each of the two floodlight switches (12 and 13) to the panel; remove the switches.
- (5) Remove the hex nut that secures the starter pushbutton (14) to the panel; remove the starter pushbutton from the rear of the panel.
- (6) Remove the machine screw that secures the lever of the ignition switch (15) to the switch; remove the lever and remove the switch from the panel.
- (7) Do not remove the identification plates from the panel unless they or the panel are damaged and require replacement.

*b. Cleaning and Inspection.*

- (1) Clean the light and ignition control panel and the electrical components with a cloth lightly dampened with an approved cleaning solvent; dry thoroughly.
- (2) Inspect the light control switch for cracks, distortion, signs of overheating, or other damage. Temporarily reinstall the levers on the switch and check all switch positions to make sure the switch operates without binding or catching. Replace if damaged.
- (3) Inspect the two toggle-type light switches for cracks, damaged terminals, and rough or catching operation; replace damaged switches.
- (4) Inspect the ignition switch for cracks, distortion, or signs of overheating. Temporarily install the lever on the switch and check the switch operation; it should operate freely without binding or catching. Replace if damaged.



MSC 3805-201-15/75

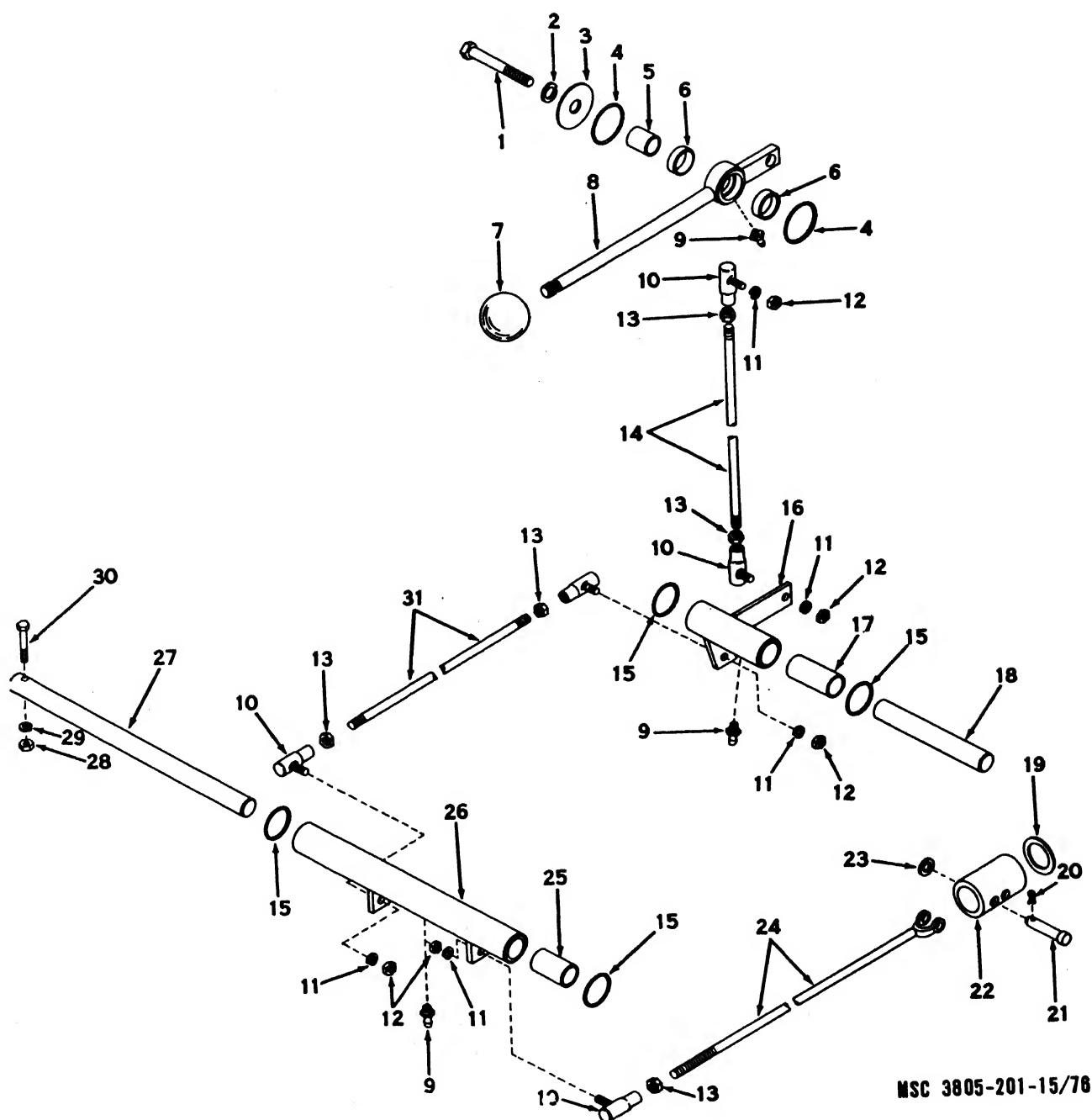
1 Ball	13 Saddle clamp	25 Nut	36 Transmission control bracket
2 Directional lever	14 Saddle clamp	26 Lockwasher	37 Capscrew
3 Nut	15 Capscrew	27 Ball joint	38 Lockwasher
4 Flat washer	16 Range lever	28 Nut	39 Nut
5 Capscrew	17 Spring	29 Rod	40 Lockwasher
6 Nut	18 Roll pin	30 Bearing	41 Forward and reverse links
7 Lockwasher	19 Range lever rod	31 Range selector bellcrank arm	42 Lubrication fitting
8 Flat washer	20 Nut	32 Roll pin	43 Capscrew
9 Quadrant	21 Plate	33 Range selector links	44 Rod
10 Jam nut	22 Bearing block	34 Clevis pin	45 Forward and reverse bellcrank
11 Bearing block	23 Bearing block	35 Cotter pin	
12 Bearing block	24 U-bolt		

Figure 75. Transmission control levers and linkage, exploded view.

- (5) Inspect the starter pushbutton for visible damage. Press the pushbutton to check the switch operation. It should operate freely. Replace if damaged.
- (6) Inspect the light and ignition control panel for cracks, distortion, and

chipped or worn paint. Touch up paint as required. Replace a damaged panel.

c. *Reassembly and Installation.* Reassemble and install the light and ignition control panel



MSC 3805-201-15/76

- |                       |                           |                                  |                               |
|-----------------------|---------------------------|----------------------------------|-------------------------------|
| 1 Capscrew            | 10 Ball joint             | 18 Transmission bellcrank shaft  | 25 Bushing                    |
| 2 Lockwasher          | 11 Lockwasher             | 19 Flat washer                   | 26 Main frame bellcrank       |
| 3 Washer              | 12 Nut                    | 20 Cotter pin                    | 27 Frame bellcrank shaft      |
| 4 Seal                | 13 Jam nut                | 21 Clevis pin                    | 28 Nut                        |
| 5 Pivot tube          | 14 Lever-to-bellcrank rod | 22 Sleeve                        | 29 Lockwasher                 |
| 6 Bushing             | 15 Preformed packing      | 23 Flat washer                   | 30 Capscrew                   |
| 7 Knob                | 16 Transmission bellcrank | 24 Bellcrank-to-transmission rod | 31 Bellcrank-to-bellcrank rod |
| 8 Lever               | 17 Bushing                |                                  |                               |
| 9 Lubrication fitting |                           |                                  |                               |

Figure 76. Azle disengage lever and linkage, exploded view.

by reversing the removal and disassembly procedure given in *a* above.

## 172. Transmission Control Levers (fig. 75)

### *a. Adjustment.*

- (1) Shift the directional lever (2) to the neutral position. The lever should line up with the N on the quadrant (9) when shifted to neutral. If it does not, loosen the nut (28) that secures the ball joint (27) to the rod connected to the directional lever (2). Remove the nut (25) and lockwasher (26) that secure the ball joint to the forward and reverse bellcrank (45). Disengage the ball joint and rod and turn the ball joint onto the rod to make the lever move toward FWD on the quadrant. Loosen the ball joint to make the lever move toward REV. Tighten the nut (28) against the ball joint when proper alignment is attained. Reconnect the ball joint to the forward and reverse bellcrank.
- (2) Shift the range lever (16) to the second speed range. The lever should align with the 2 on the quadrant (9). If it does not, loosen the nut (28) that secures the ball joint (27) to the rod connected to the range lever rod (19). Remove the nut (25) and lockwasher (26) that secure the ball joint to the range selector bellcrank arm (31); disengage the ball joint and rod. Turn the ball joint farther onto the rod to make the range lever move toward 1 on the quadrant. Loosen the ball joint to make the lever move toward 3. Tighten the nut (28) against the ball joint when proper alignment is attained. Reconnect the ball joint to the range selector bellcrank arm.

### *b. Removal and Disassembly.*

- (1) Remove the nuts (25) and lockwashers (26) that secure the ball joints (27) to their respective bellcranks and shift levers; remove the assembled bellcranks and rods (29). Disassemble the bellcranks and nuts (28) from the rods.
- (2) Remove the cotter pins (35) and clevis pins (34) that secure their re-

spective links (33 and 41) to the bellcranks and to the plungers on the transmission control valve; remove the links.

- (3) Remove the two capscrews (43), lockwashers (40), and nuts (39) that secure the bellcrank bearings (30) to the transmission control bracket (36); remove the assembled bellcrank and bearing assembly. Remove the bearings from the ends of the bellcrank.
- (4) Drive out the roll pins (32) that secure the range selector bellcrank arms (31) to the rod (44); remove the bellcrank arms and the forward and reverse bellcrank (45) from the rod.
- (5) Remove the two nuts (20) and U-bolts (24) that secure the bearing blocks (22 and 23) to the steering column; remove the plate (21) and bearing blocks.
- (6) Remove the self-locking nut (3) and flat washer (4) that secure the quadrant (9) to the capscrews (15); remove the quadrant.
- (7) Remove the lever stop capscrews (5), nut (6), lockwasher (7), and flat washer (8) from the quadrant.
- (8) Remove the capscrews (15) and jam nuts (10) that secure the bearing blocks (11 and 12) and saddle clamps (13 and 14) to the steering column; remove the blocks and clamps.
- (9) Drive out the roll pin (18) and remove the range lever (16) from the range lever rod (19). Remove the spring (17) from the rod.

### *c. Cleaning and Inspection.*

- (1) Clean all parts with an approved cleaning solvent. Clean threaded parts with a wire brush. Dry with clean, dry compressed air.
- (2) Inspect the shift quadrant for legibility of characters and shift rods and levers for condition of paint; repaint if necessary.
- (3) Inspect all parts for cracks, bending, and condition of welds; repair if necessary.
- (4) Inspect the spring for distortion or weakness.
- (5) Repair or replace all defective parts.

d. *Reassembly and Installation.* Reassembly and installation is the reverse of the removal and disassembly procedure described in b above.

### 173. Axle Disengage Lever and Linkage (fig. 76)

#### a. *Removal and Disassembly.*

- (1) Remove the cotter pin (20), clevis pin (21), and flat washer (23) that secure the bellcrank-to-transmission rod (24) at the sleeve (22) to the axle disconnect shaft on the transmission; disconnect the rod and remove the coupling and flat washers (19).
- (2) Loosen the jamnuts (13) that secure each ball joint (10) to its respective rod end. Remove the nut (12) and lockwasher (11) that secure the ball joint to its bellcrank or lever and remove the lever-to-bellcrank rod (14), the bellcrank-to-transmission rod (24), and the bellcrank-to-bellcrank rod (31) with their attached ball joints (10) and jam nuts (13). Remove the ball joints and nuts from the rods.
- (3) Remove the two capscrews (30), nuts (28), and lockwashers (29) that secure the frame bellcrank shaft (27) to the bracket on the frame; remove the shaft, main frame bellcrank (26), and preformed packing (15). If worn or damaged, remove the bushings (25) from the bellcrank.
- (4) Remove the transmission bellcrank shaft (18) from the transmission and remove the transmission bellcrank (16) and preformed packings (15). Do not remove the bushings (17) from the bellcrank unless they are worn or damaged.
- (5) Remove the capscrew (1), lockwasher (2), and flat washer (3); secure the axle disengage lever (8) to the frame; remove the lever and seals (4).
- (6) If the bushings (6) are worn or damaged, use a soft drift to drive them from the lever.

#### b. *Cleaning and Inspection.*

- (1) Clean all parts in an approved cleaning solvent; wipe dry with a clean cloth.
- (2) Inspect the ball joint for cracks and damaged threads. Make sure that the

ball joint is well lubricated and works freely.

- (3) Inspect the bellcrank for cracks, distortion, and worn bushings. If bushings require replacement, press new bushings in place in the bellcrank.
- (4) Inspect the axle disengage lever for cracks and distortion. If bushings require replacement, press new bushings in place in the lever.
- (5) Inspect all other parts for cracks, worn or damaged threads, distortion, or other damage; replace damaged parts.

c. *Reassembly and Installation.* Reassemble and install the axle disengage lever and linkage by reversing the removal and disassembly procedures given in a above.

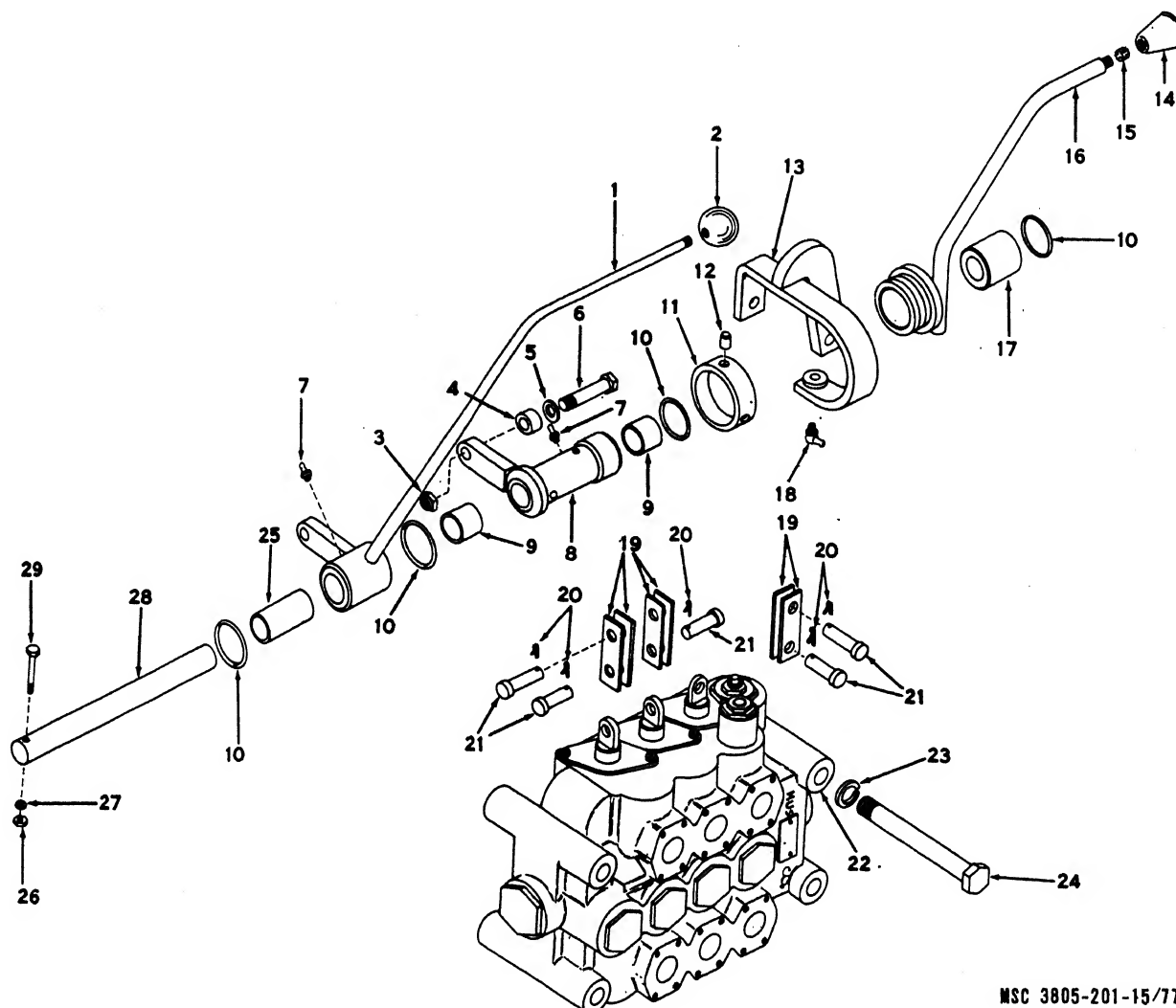
### 174. Boom and Bucket and Accessory Control Levers (fig. 77)

#### a. *Removal and Disassembly.*

- (1) Remove the cotter pins (20) and clevis pins (21) that connect the links (19) to the hydraulic control valve (22), the boom control lever (1), and the yoke (13) of the bucket and accessory control lever; remove the links.
- (2) Remove the capscrew (6), locknut (3), and flat washer (5) that hold the links (19) to the hub assembly (8); remove the links and spacer (4).
- (3) Remove the capscrew (29), nut (26), and lockwasher (27) that secure the shaft (28) to the bracket on the hydraulic manifold. Tap out the shaft and catch the preformed packings (10), spacer (17), assembled bucket and accessory control lever (16), yoke (13), ring (11), pin (12), hub assembly (8), and boom control lever (1).
- (4) Disassemble the bucket and accessory control lever (16) and the yoke (13) from the hub assembly.
- (5) Remove the ball (2) from the boom control lever (1). Remove the knob (14) and tolerance ring (15) from the bucket and accessory control lever (16).

#### b. *Cleaning and Inspection.*

- (1) Clean all parts with an approved cleaning solvent; dry thoroughly.



MSC 3805-201-15/77

1 Boom control lever	9 Bearing	17 Spacer	23 Lockwasher
2 Ball	10 Preformed packing	18 Lubrication fitting	24 Capscrew
3 Locknut	11 Ring	19 Link	25 Bearing
4 Spacer	12 Pin	20 Cotter pin	26 Nut
5 Flat washer	13 Yoke	21 Clevis pin	27 Lockwasher
6 Capscrew	14 Knob	22 Hydraulic control valve	28 Shaft
7 Lubrication fitting	15 Tolerance ring		29 Capscrew
8 Hub assembly	16 Bucket and accessory control lever		

Figure 77. Boom and bucket and accessory control levers, exploded view.

- (2) Inspect the hub assembly (8) and boom lever assembly for cracks or broken weldments. Check the bearings (9 and 25) for wear or scoring. If the bearings are damaged, press them out and replace with new bearings.
- (3) Inspect all other parts for cracks, wear, distortion, or other damage; replace damaged parts.

c. *Reassembly and Installation.* Reassemble and install the boom and bucket and accessory

control levers by reversing the removal and disassembly procedures described in a above.

## 175. Parking Brake Lever and Linkage

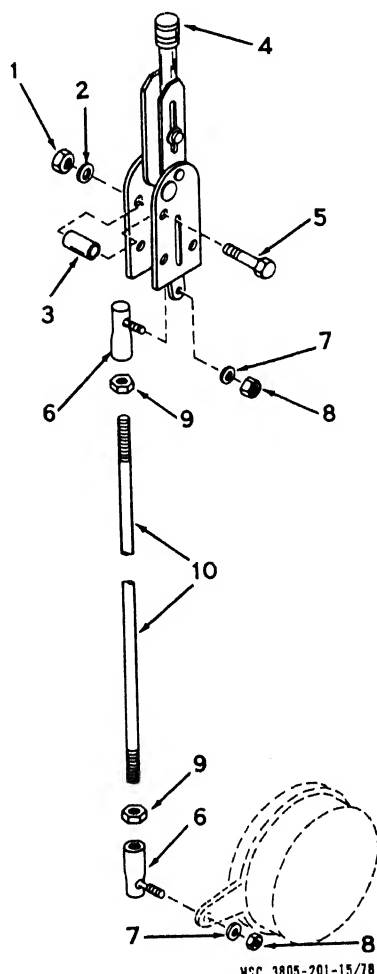
### a. Lever Adjustment.

- (1) Release the parking brake lever (32, fig. 10) to relieve the tension on the brake rod; turn the knurled handle a few turns clockwise to take up the slack. Apply the parking brake to check the tension.

- (2) When the parking brake is properly adjusted, the lever pull should become heavy about three-quarters of the way to the fully applied position, and the lever should snap into the vertical or applied position.

*b. Linkage Adjustment (fig. 78).*

- (1) Block the wheels of the loader.
- (2) When the slack can no longer be taken up by adjusting the parking brake lever, turn the knurled handle counter-



- |                       |                      |
|-----------------------|----------------------|
| 1 Nut                 | 6 Ball joint         |
| 2 Lockwasher          | 7 Lockwasher         |
| 3 Spacer              | 8 Nut                |
| 4 Parking brake lever | 9 Nut                |
| 5 Capscrew            | 10 Parking brake rod |

Figure 78. Parking brake lever and linkage, exploded view.

- clockwise to loosen the brake linkage.
- (3) Remove the nut (8) and lockwasher (7) that secure the lower ball joint (6) to the arm on the parking brake. Loosen the nut (9) that secures the lower ball joint to the parking brake rod. Turn the ball joint clockwise onto the rod to take up slack in the linkage. Reconnect the lower ball joint to the arm of the parking brake and perform the lever adjustment as directed in a above.
- (4) If necessary, take up additional slack by repositioning the ball joint (6) at the parking brake lever end of the parking brake rod.

*c. Removal.*

- (1) Remove the nuts (8) and lockwashers (7) that secure the ball joints (6) to the arm of the parking brake and to the parking brake lever (4); remove the assembled ball joints and parking brake rod (10). Disassemble the ball joints and nuts (9) from the rod.
- (2) Remove the two capscrews (5), nuts (1), and lockwashers (2) that secure the parking brake lever (4) to the loader frame; remove the parking brake lever and spacers (3).

*d. Cleaning and Inspection.*

- (1) Clean all parts thoroughly with an approved cleaning solvent; dry thoroughly.
- (2) Inspect the ball joints for cracks, hard swiveling of the joint, distortion, or damaged threads; replace damaged ball joints.
- (3) Inspect the parking brake rod for bends, cracks, or damaged threads; straighten the rod if necessary. Replace if badly damaged.
- (4) Inspect all other parts for cracks, worn or damaged threads, or other damage; replace defective parts.

*e. Installation.* Install the parking brake lever and linkage by reversing the removal procedure described in c above.

## Section XI. CHASSIS ASSEMBLY

### 176. General

- a.* This section covers the wheels, tires, grille,

counterweight, floorboard and ladder, hood, battery box, hydraulic manifold enclosure, seat,



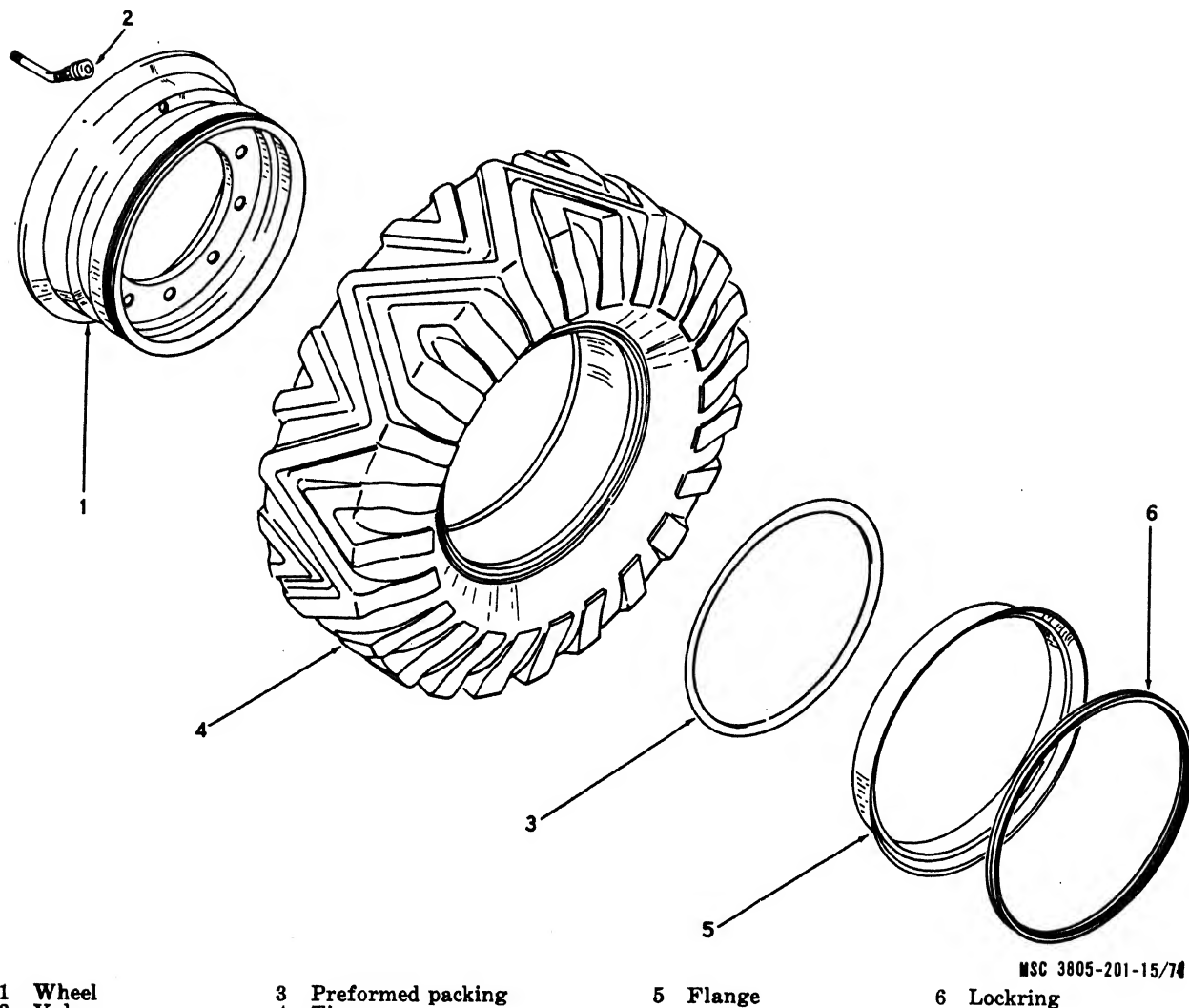


Figure 79. Wheel and tire, exploded view.

and other miscellaneous panels and parts of the loader.

b. The tires are tubeless mounted on the wheels with a flange and lockring.

c. The grille and counterweight are heavy castings mounted on the rear of the loader to counterbalance the load scooped up by the bucket.

d. The floorboards consist of two steel plates that mount on the loader frame in the operator's compartment. A ladder is mounted on the left end of the rear floorboard to facilitate mounting and dismounting from the loader.

e. The battery box and hydraulic manifold enclosure are mounted on the main frame with battery box to the left of the operator's compartment and the hydraulic enclosure to the right. The operator's seat is mounted in the rear of the

compartment between the enclosure and battery box.

## 177. Weels and Tires

### a. Removal and Disassembly (fig. 79).

- (1) Engage the axle disengage lever and set the parking brake.
- (2) With a suitable jack or hoist, lift the wheel about 2 inches from the ground.
- (3) Remove the 12 hex nuts that secure the wheel (1) to the axle; remove the assembled wheel and tire (4).
- (4) Release the air pressure from the tire.
- (5) Force a tire tool between the lockring (6) and the flange (5); pry off the lockring and remove the flange from the wheel.

**Warning:** Stand to one side when prying the lockring from the flange. The lockring may spring out suddenly and cause personal injury to someone standing directly in front of it.

- (6) Remove the tire (4), valve (2), and preformed packing (3) from the wheel.

*b. Cleaning and Inspection.*

- (1) Wipe all dirt, grease, or mud from the exterior of the tire with a damp cloth.
- (2) Wipe the interior of the tire with a damp cloth to remove any dirt or cinders.
- (3) Inspect the exterior of the tire for bad cuts or abrasions. Remove all stones or foreign matter lodged in the tire treads.
- (4) Inspect and feel the interior surface of the tire for sharp objects or protrusions.
- (5) Inspect the wheel for out-of-round, cracks, or flat spots.
- (6) Remove all dirt, mud, and rust with a wire brush.
- (7) Replace all unserviceable parts.

*c. Reassembly and Installation.* Reassemble and install the tire and wheel by reversing the removal and disassembly procedure given in *a* above.

## 178. Grille

*a. Removal.*

- (1) Remove the lights as directed in paragraphs 142b (3), 144b, and 145b.
- (2) Remove the hood and engine side panels as directed in paragraph 182a.
- (3) Secure the grille (13, fig. 54) to a chain hoist capable of lifting at least 1,000 pounds. Be sure the supporting chains are tight and have no slack.

**Warning:** The grille is very heavy. When removing it, support it near the top with a hoist of sufficient strength. Keep hands and feet out from under the grille during removal.

- (4) Remove the three capscrews (16), flat washers, lockwashers, and nuts that secure the grille to the loader frame; carefully remove the grille and rest it flat on the ground.

*b. Cleaning and Inspection.*

- (1) Check the three mounting capscrews for nicks, burrs, and damaged threads.
- (2) Check the grille for cracks and breaks. Weld the cracks if possible.
- (3) Check the grille for rust and other corrosion. Clean with a wire brush and repaint if necessary.
- (4) Replace all unserviceable parts.

*c. Installation.* Install the grille by reversing the removal procedure given in *a* above.

## 179. Counterweight

*a. Removal (fig. 54).*

- (1) Position suitable jacks to support the counterweight (14).
- (2) Remove the three capscrews (15), flat washers, lockwashers, and nuts that secure the counterweight to the loader frame; carefully lower the counterweight from the main frame.

*b. Cleaning and Inspection.*

- (1) Wash the counterweight with water; remove grease or oil by wiping with a cloth containing an approved solvent.
- (2) Inspect the counterweight for cracks or breaks; repair cracks by welding if possible. Touch up the paint if necessary.
- (3) Inspect the bolts and nuts for cracks, distortion, or stripped threads; replace unserviceable parts.

*c. Installation.* Install the counterweight by reversing the removal procedure given in *a* above.

## 180. Battery Box

*a. Removal (fig. 47).*

- (1) Remove the air cleaner as directed in paragraph 128b.
- (2) Remove the batteries as directed in paragraph 137b.
- (3) Remove the receptacle and terminal block as directed in paragraph 146a (3) and (4).
- (4) Pull the battery cables from the battery box (16) through the grommet (10).
- (5) Remove the four capscrews (13), nuts (15), and lockwashers (14) that secure the battery box (16) to the loader frame; remove the battery box.

- (6) Remove the grommet (10) from the battery box.

*b. Cleaning and Inspection.*

- (1) Clean the battery box and holder with a mild solution of bicarbonate of soda and water to flush out all battery acid. Remove any gummy or greasy deposits with a cloth dampened with an approved cleaning solvent; dry thoroughly.
- (2) Wipe the grommet with a clean, dry cloth.
- (3) Inspect the battery box and battery holder for cracked weldments, distortion, worn or damaged threads, or other damage. Check the battery box hinges for free operation. Replace damaged parts.
- (4) Inspect the grommet for cracks or deterioration; replace if damaged.

*c. Installation.* Install the battery box by reversing the removal procedure given in *a* above.

## **181. Floorboards and Ladder**

*a. Removal.*

- (1) Remove the blackout headlight from the ladder rail as directed in paragraph 143b.
- (2) Remove the hand throttle lever and foot throttle pedal from the floorboards as directed in paragraphs 169b and 168b.
- (3) Remove the seven capscrews (9 and 22, fig. 80), lockwashers (11 and 21), five flat washers (10), and five nuts (12) that secure the rear floorboard (8) to the floorboard runner (7) and to the loader frame; remove the rear floorboard.
- (4) Remove the treadle valve from the front floorboard (1) as directed in paragraph 191a.
- (5) Remove the parking brake lever from the loader as directed in paragraph 175c.
- (6) Remove the lever-to-bellcrank rod (14, fig. 76) and assembled ball joints (10) by removing the nuts (12) and lockwashers (11) that secure them to their respective parts.
- (7) Remove the five capscrews (4 and 27, fig. 80), five lockwashers (3 and 24), seven flat washers (2, 25, and 26), and

two nuts (23) that secure the front floorboard (1) to the loader frame; remove the front floorboard.

- (8) Do not remove the floorboard runner (7) unless it is damaged and requires replacement.

*b. Cleaning and Inspection.*

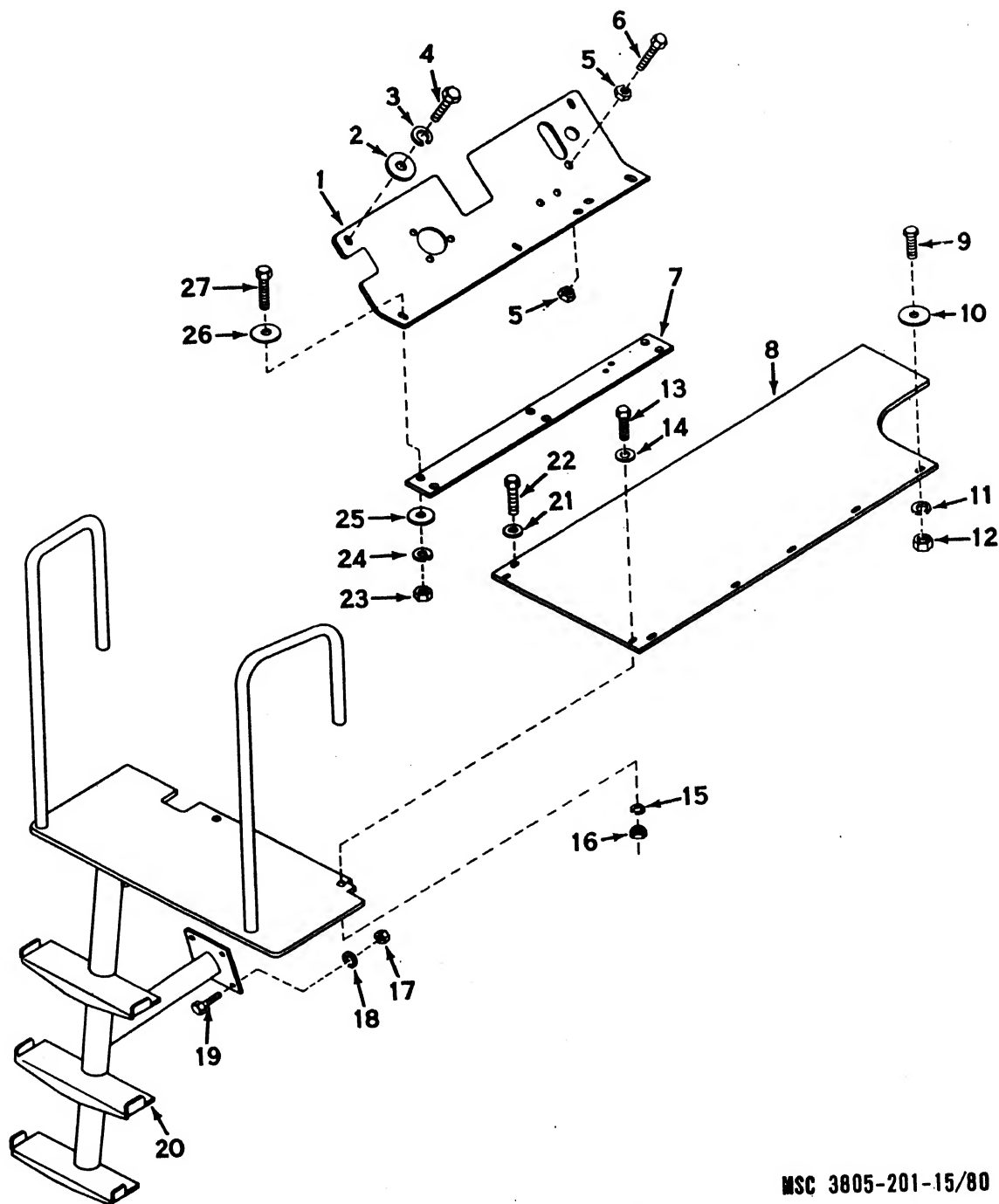
- (1) Clean the floorboard with water under pressure; dry thoroughly. Remove gummy and oily spots with a cloth dampened in solvent.
- (2) Check the floorboards, ladder, and runner for cracks, rusting, or other damage or deterioration. Weld cracks and breaks when practical; replace unserviceable parts. Clean corroded parts with a wire brush and repaint when practical.
- (3) Check all threaded parts for worn or damaged threads; replace unserviceable parts.

*c. Installation.* Install the floorboards by reversing the removal procedure given in *a* above.

## **182. Hood and Panels**

*a. Removal (fig. 81).*

- (1) Remove the right rear and left rear panels (44) from the loader by unlatching the latches (46) and lifting the panels from the rivets in the hood (3).
- (2) Remove the bumpers (48) by removing the machine screw (47), nut (50), and lockwasher (49), that secure each bumper to the outside of the rear panel (44).
- (3) Remove the latches (46) by removing the three drive screws (45) that secure each latch to the main frame.
- (4) Remove the right rear side panel and the left rear side panel (43) by removing the three capscrews (42), lockwashers (41), and flat washers (40) that secure each panel to the loader.
- (5) To remove the hood (3), first remove the exhaust pipe as directed in paragraph 162a. Remove the service and emergency air connections and fittings as directed in paragraph 194a. Remove the air cleaner and connections as directed in paragraph 128b. Remove the capscrews (1 and 4),



MSC 3805-201-15/80

- 1 Front floorboard
- 2 Flat washer
- 3 Lockwasher
- 4 Capscrew
- 5 Locknut
- 6 Capscrew
- 7 Runner

- 8 Rear floorboard
- 9 Capscrew
- 10 Flat washer
- 11 Lockwasher
- 12 Nut
- 13 Capscrew
- 14 Flat washer

- 15 Lockwasher
- 16 Nut
- 17 Nut
- 18 Lockwasher
- 19 Capscrew
- 20 Ladder
- 21 Lockwasher

- 22 Capscrew
- 23 Nut
- 24 Lockwasher
- 25 Flat washer
- 26 Flat washer
- 27 Capscrew

Figure 80. Floorboards and ladder, exploded view.

lockwashers (52), nuts (51), and flat washers (2) that secure the hood to the loader; keep the rear mounting

capscrews separated from the front mounting capscrews. Remove the hood from the loader.

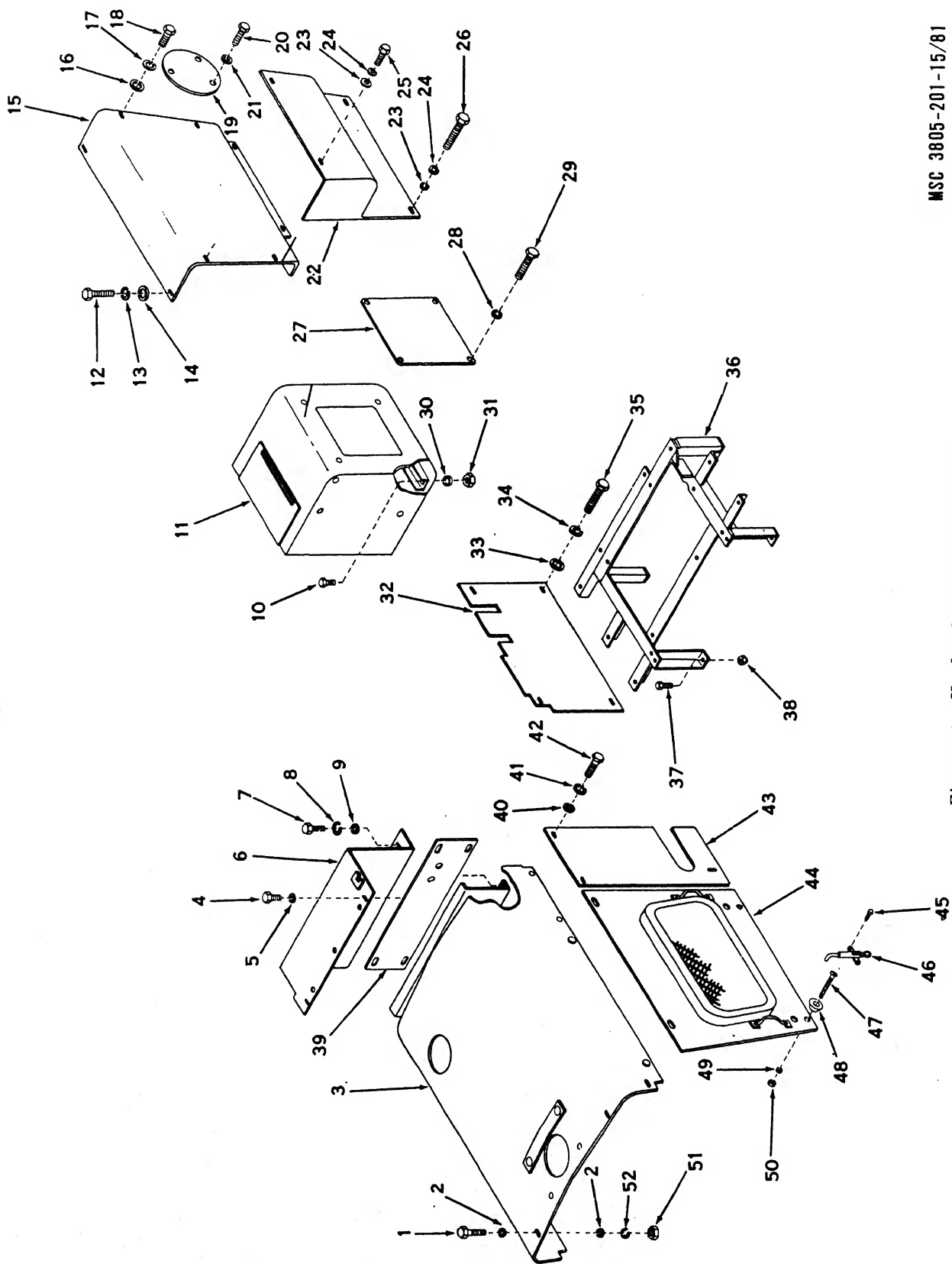


Figure 81. Hood and panels, exploded view.

MSC 3805-201-15/81

1 Capscrew	13 Lockwasher	27 Cover	40 Flat washer
2 Flat washer	14 Flat washer	28 Lockwasher	41 Lockwasher
3 Hood	15 Forward upper panel	29 Capscrew	42 Capscrew
4 Capscrew	16 Flat washer	30 Lockwasher	43 Rear side panel
5 Lockwasher	17 Lockwasher	31 Nut	44 Rear panel
6 Operator's compartment panel	18 Capscrew	32 Center panel	45 Drive screw
7 Capscrew	19 Access cover	33 Flat washer	46 Latch
8 Lockwasher	20 Capscrew	34 Lockwasher	47 Machine screw
9 Flat washer	21 Lockwasher	35 Capscrew	48 Bumper
10 Capscrew	22 Forward lower panel	36 Operator's compartment support	49 Lockwasher
11 Hydraulic manifold enclosure	23 Flat washer	37 Capscrew	50 Nut
12 Capscrew	24 Lockwasher	38 Locknut	51 Nut
	25 Capscrew	39 Operator's compartment plate	52 Lockwasher
	26 Capscrew		

Figure 81—Continued.

- (6) Remove the operator's compartment panel (6) and the operator's compartment plate (39) by removing the two capscrews (7), lockwashers (8), and flat washers (9) that secure the panel to the loader.
- (7) Remove the right center panel and the left center panel (32) by removing the four capscrews (35), lockwashers (34), and flat washers (33) that secure each panel to the loader.
- (8) Remove the right forward lower panel and the left lower panel (22) by removing the four capscrews (25 and 26), lockwashers (24), and flat washers (23) that secure each panel to the loader.
- (9) Remove the six capscrews (12 and 18), lockwashers (13 and 17), and flat washers (14 and 16) that secure the panels to the loader; remove the panels.
- (10) Remove the access covers (19) on each side of the loader by removing the three capscrews (20) and lockwashers (21) that secure each cover to the loader.

*b. Cleaning and Inspection.*

- (1) Clean the hood and panels with a damp cloth. Remove any oily or gummy deposits with a cloth moistened with an approved cleaning solvent. Clean all other parts in solvent.
- (2) Check all threaded parts for nicks, burrs, and damaged threads.
- (3) Check the panels and the hood for dents, cracks, tears, and other damage. Fill and grind if practicable.
- (4) Check the panels and the hood and tool box for rust and other corrosion;

if necessary, clean with a wire brush and repaint.

- (5) Check the rubber bumpers for deterioration and excessive wear.
- (6) Check the latches for wear and proper operation.
- (7) Replace all unserviceable parts.

*c. Installation.* Install the hood and panel parts by reversing the removal procedure given in *a* above.

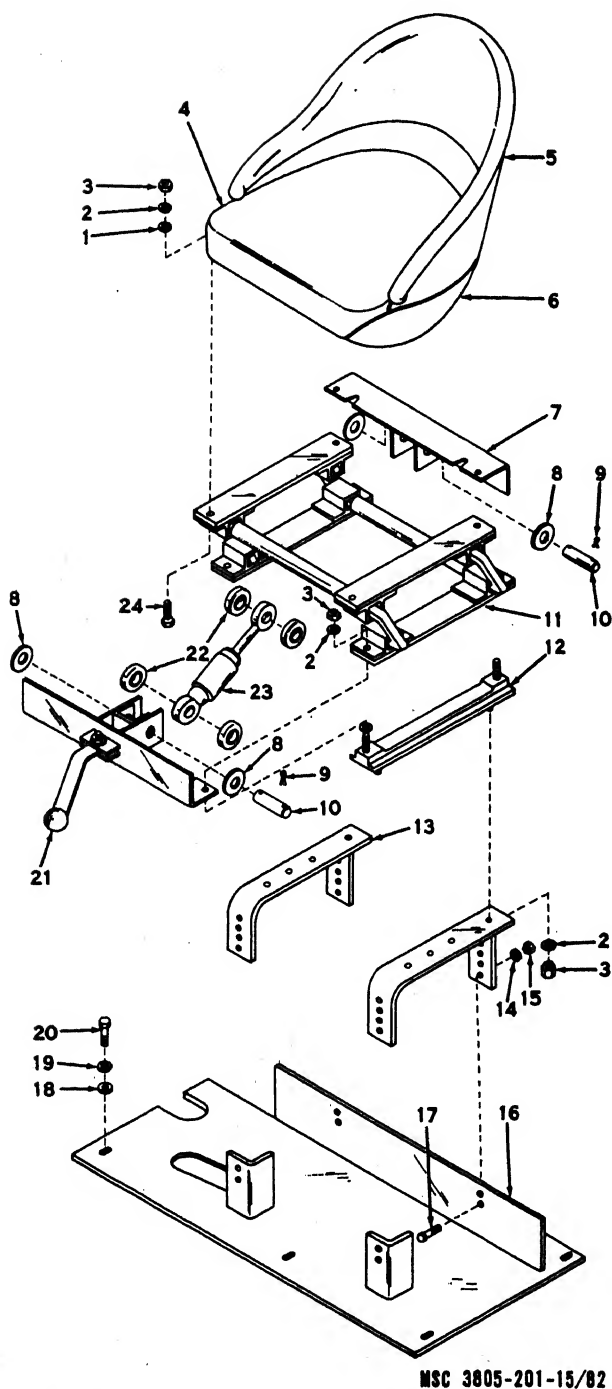
### 183. Hydraulic Manifold Enclosure

*a. Removal (fig. 81).*

- (1) Remove the four capscrews (29) and lockwashers (28) that secure the hydraulic manifold enclosure cover (27) to the hydraulic manifold enclosure (11); remove the cover.
- (2) Remove the hydraulic reservoir from the loader as directed in paragraph 249a.
- (3) Remove the forward upper panel from the loader as directed in paragraph 182a.
- (4) Remove the boom and bucket and accessory control levers from the loader as directed in paragraph 174a.
- (5) Remove the hydraulic control valve from the loader as directed in paragraph 207b.
- (6) Remove the four capscrews (10), nuts (31), and lockwashers (30) that secure the hydraulic manifold enclosure to the operator's compartment support (36); remove the enclosure.

*b. Cleaning and Inspection.*

- (1) Clean the hydraulic manifold enclosure with an approved cleaning solvent.



1 Washer	13 Seat support
2 Lockwasher	14 Lockwasher
3 Nut	15 Nut
4 Seat cushion	16 Seat deck
5 Seat backrest	17 Capscrew
6 Shell	18 Flat washer
7 Anchor plate	19 Lockwasher
8 Flat washer	20 Capscrew
9 Cotter pin	21 Shock absorber handle
10 Pin	22 Rubber bushing
11 Seat suspension assembly	23 Shock absorber
12 Slide assembly	24 Capscrew

Figure 82. Seat and support, exploded view.

- (2) Remove rust and other corrosion with a wire brush; repaint if necessary.
- (3) Check the hydraulic manifold enclosure for cracks, breaks, dents, and other damage.
- (4) Check threaded parts for worn or damaged threads.
- (5) Replace all unserviceable parts.

c. *Installation.* Install the hydraulic manifold enclosure by reversing the removal procedure given in a above.

#### 184. Seat and Support (fig. 82)

##### a. *Removal and Disassembly.*

- (1) Remove the four capscrews (24), washers (1), lockwashers (2), and nuts (3) that secure the seat assembly (11). Remove the seat assembly and, if necessary, disassemble the seat cushion (4), backrest (5), and shell (6).
- (2) Remove the two cotter pins (9), pin (10), and flat washers (8) that secure the shock absorber (23) to the shock absorber handle (21). Remove the two rubber bushings (22). Remove the two cotter pins (9), pin (10), and flat washers (8) that secure the shock absorber to the anchor plate (7); remove the shock absorber and two rubber bushings.
- (3) Remove the four nuts (3) and lockwashers (2) that secure the suspension assembly to the slide assemblies (12); remove the suspension assembly, shock absorber handle, and four washers (1).
- (4) Remove the four nuts (3) and lockwashers (2) that secure the two slide assemblies (12) to the seat supports (13) and remove the slide assemblies.
- (5) Remove the four capscrews (17), lockwashers (14), and nuts (15) that secure the two seat supports to the seat deck (16); remove the seat supports.
- (6) Remove the five capscrews (20), lockwashers (19), and flat washers (18) that secure the seat deck to the frame; remove the seat deck.

*b. Cleaning and Inspection.*

- (1) Clean all metal parts with an approved cleaning solvent. Dry with clean, dry, compressed air.
- (2) Wash the seat cushion and backrest with soap and water. Dry with a clean, dry cloth.
- (3) Inspect all metal parts for cracks, breaks, or excessive rust. Inspect the parts for the condition of the paint; repaint if necessary.

(4) Inspect the seat cushion and backrest for tears, excessive damage, or wear. Repair or replace if necessary.

(5) Inspect the shock absorber for evidence of excessive leakage. Replace if necessary.

(6) Repair or replace all defective parts.

*c. Reassembly and Installation.* Reassemble and install the seat and support by reversing the removal and disassembly procedure described in *a* above.

## Section XII. BRAKE SYSTEM

### 185. General

*a.* The brake system of the loader is a combination air and hydraulic type. When the treadle valve (5, fig. 83) on the floor of the operator's compartment is depressed, air pressure from the air reservoir (11) is metered to the air cylinder of the power cluster (8) and to the service coupling (40). Also, when the driver operates the treadle valve, an air line to the transmission control valve disengages the transmission, releasing all hydraulic pressure to the transmission clutches, thus disconnecting all power from the transmission to the drive axles. The service coupling provides air for the brake system of a towed vehicle. The emergency coupling (39) supplies air for the emergency brake system of a towed vehicle. The power cluster is a combination air cylinder and hydraulic master cylinder used to raise the applied air pressure to the relatively high hydraulic pressure required for hydraulic braking. The hydraulic cylinder of the power cluster forces brake fluid through the hydraulic lines (9 and 18) to the hydraulic cylinders at each wheel. The pressure exerted on the pistons of the wheel cylinders expands the brake shoes against the brake drums to slow or stop the loader.

*b.* The air pressure is supplied by the air compressor (36), which is mounted on and driven by the engine. The actual compression of air is controlled by the air governor (33), which actuates an unloader valve in the compressor to stop compression of air when the maximum pressure of 85 to 105 psi is reached, and restarts compression when the air pressure drops to the minimum of 80 to 85 psi.

*c.* A handbrake valve (1), mounted on the steering column, controls the flow of air to the

service air coupling for independent control of the brakes of a towed vehicle.

*d.* An air pressure gage (4) on the instrument panel indicates the pressure in the air system, and a low pressure indicator (23) signals when the pressure in the system is below 60 psi.

*e.* The air horn is controlled by a solenoid valve which opens the passage to the horn when the horn button is depressed.

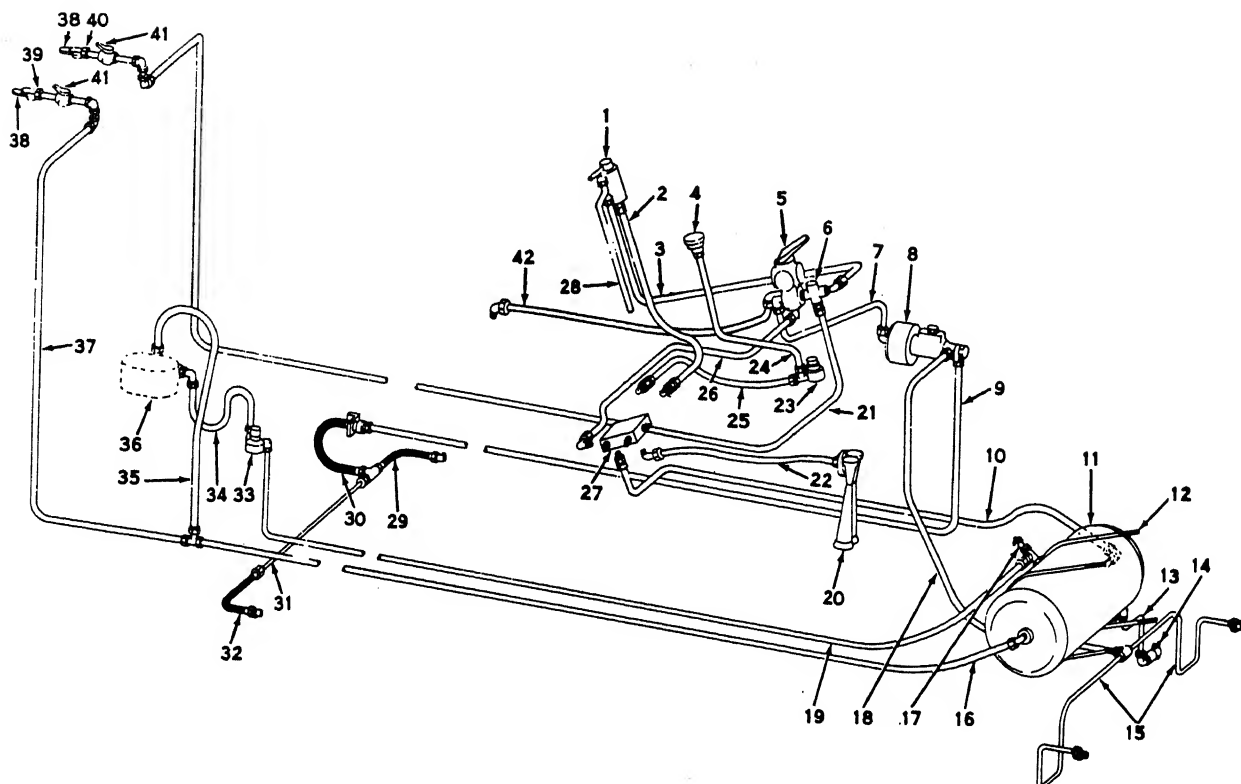
*f.* The safety valve (17), mounted on the top of the air reservoir (11), protects the air brake system against excessive air pressure above 150 psi. The safety valve consists of a spring-loaded ball check valve which lifts and permits air to exhaust to atmosphere if the pressure in the reservoir rises above its setting.

*g.* The double check valve (6) prevents loss of air pressure through the open exhaust port of the hand brake valve (1) when the treadle valve (5) is used, or through the exhaust port of the treadle valve when the hand brake valve is used. This permits both to be connected to the service coupling (40). Air pressure entering from one end or the other causes a disk valve to move and block off the port on the opposite end, but does not restrict the flow to the port on the side of the double check valve.

*h.* The low pressure indicator (23) is a safety device designed to give an automatic warning to the operator whenever the pressure in the air brake system is below the minimum advisable pressure for normal vehicle operation. It mounts below the instrument panel and actuates a buzzer when the air pressure is below 60 psi.

*i.* The parking brake, mounted on the lower front side of the transmission, is an expanding-shoe-type brake. When the operator moves the





MSC 3005-201-15/03

- |   |   |   |   |
|---|---|---|---|
| 1 Hand brake valve                            | 13 Reservoir drain tube                   | 24 Low pressure indicator-to-air pressure gage tube | 32 Rear brake tube-to-right rear brake hose     |
| 2 Manifold-to-hand brake valve tube           | 14 Drain cock                             | 25 Manifold-to-low pressure indicator tube          | 33 Governor                                     |
| 3 Hand brake valve-to-double check valve tube | 15 Front brake tube                       | 26 Manifold-to-treadle valve tube                   | 34 Governor-to-compressor tube                  |
| 4 Air pressure gage                           | 16 Compressor-to-reservoir tube           | 27 Manifold   | 35 Compressor outlet tube                       |
| 5 Treadle valve                               | 17 Safety valve                           | 28 Hand brake valve exhaust tube                    | 36 Air compressor                               |
| 6 Double check valve                          | 18 Power cluster-to-front brakes tube     | 29 Power cluster tube-to-left rear brake hose       | 37 Emergency coupling-to-compressor outlet tube |
| 7 Treadle valve-to-power cluster tube         | 19 Reservoir-to-governor tube             | 30 Power cluster tube-to-rear brake hose            | 38 Dummy coupling                               |
| 8 Power cluster                               | 20 Horn                                   | 31 Rear brake hose-to-right rear brake tube         | 39 Emergency coupling                           |
| 9 Power cluster-to-rear brake tube            | 21 Double check valve-to-service coupling |   | 40 Service coupling                             |
| 10 Reservoir-to-manifold tube                 | 22 Manifold-to-horn tube                  |   | 41 Cutout cock                                  |
| 11 Air reservoir                              | 23 Low pressure indicator                 |   | 42 Treadle valve-to-transmission tube           |
| 12 U-bolt                                     |   |   |   |

Figure 83. Air brake system, schematic view.

parking brake lever (32, fig. 10) in the operator's compartment to the ON position, two brakeshoes, mounted on a plate that is fastened to the transmission housing, are forced outward against a brake drum that rotates with the front drive shaft. The friction of the brake shoe linings against the brake drum acts to hold the drive shaft in a stationary position.

## 186. Adjustments

### a. Adjustment.

- (1) Remove the access cover (19, fig. 81). With normal air pressure in the air

reservoir, depress the treadle valve fully to apply the brakes; at the same time have an assistant measure the travel of the stroke indicator of the power cluster, as shown in figure 84.

- (2) Normal travel is  $3/8$  to  $3/4$  inch; greater travel indicates low brake fluid or need of brake adjustment. If fluid is low, fill to the top with clean hydraulic brake fluid.
- (3) Place all controls in neutral and block all wheels except the one to be ad-

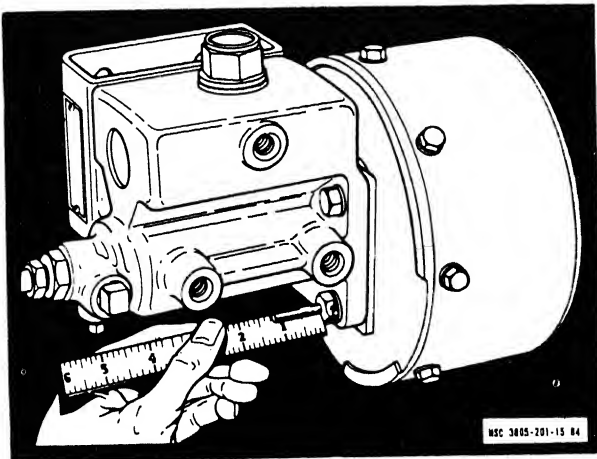


Figure 84. Checking stroke indicator for brake adjustment.

justed; jack up the loader so the wheel to be adjusted can be rotated freely.

- (4) An adjustment cam is located near the hydraulic cylinder end of each brake shoe (fig. 85). Turn the right cam clockwise and the left cam counterclockwise to bring the lining into contact with the drum; back off each cam to permit free rotation of the wheel.
- (5) When all four wheels have been adjusted, repeat (1) above. If the travel of the stroke indicator continues to be excessive, it indicates the need of bleeding the brake system as directed in *b* below, or leakage of brake fluid at some point of the hydraulic brake system.
- (6) Lower the loader to the ground and remove all blocking.

*b. Bleeding the Hydraulic Brake System.* Proper operation of the brakes requires a complete absence of air bubbles at all points in the hydraulic brake system. After overhaul or other conditions that have allowed air bubbles to be mixed with the brake fluid, it is necessary to bleed the hydraulic brake fluid from the system at various points to expel any air bubbles. The necessity for bleeding is indicated by excessive travel (beyond  $3/4$  inch) of the power cluster piston stroke indicator when all of the brakes have been adjusted and the treadle valve is depressed. Air in the hydraulic brake system can be caused by extremely low fluid in the hydraulic cylinder of the power cluster, or by faulty pis-

ton cups in the wheel cylinder or the hydraulic cylinder.

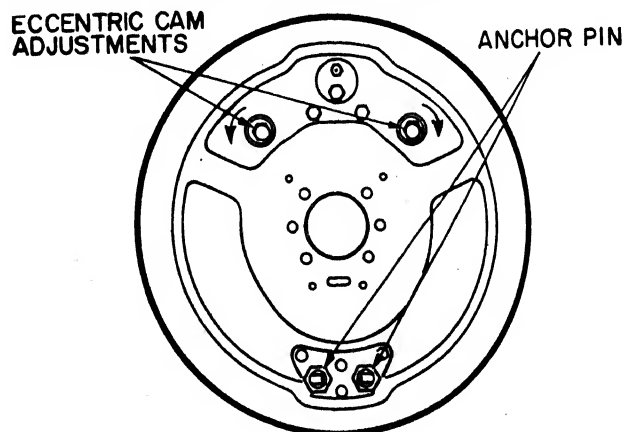
*Note.* When bleeding the hydraulic brake lines, be sure to maintain a full supply of clean brake fluid in the hydraulic cylinder of the power cluster.

- (1) Position one end of a brake bleeder hose, approximately 15 inches long, on the brake bleeder screw adjacent to the hydraulic fitting on the dump valve of the transmission. Place the other end of the hose in a glass jar containing a small amount of brake fluid.
- (2) Loosen the bleeder screw while a helper slowly depresses the treadle valve; tighten the bleeder screw before the treadle valve is released. Bubbles rising in the fluid in the glass jar indicate the presence of air in the system. Repeat this procedure until there is no sign of air in the brake fluid being pumped from the bleeder screw.
- (3) Follow the procedure described above at the bleeder screw of each hydraulic wheel cylinder.

*Note.* Fluid withdrawn from the brake system should not be used again. Keep the hydraulic cylinder of the power cluster filled with clean brake fluid during the bleeding operation to prevent more air from entering the system.

## 187. Safety Valve (fig. 83)

*a. Operating Test.* With the air pressure gage (4) indicating normal operating pressure



ARROW SHOWS ROTATION DIRECTION  
NECESSARY TO EXPAND SHOES

MSC 3805-201-15/85

Figure 85. Brake shoe adjustment.

in the system, pull the exposed end of the release pin of the safety valve (17). This will remove the spring tension from the steel ball and allow air to escape through the exhaust port. If the safety valve does not "blow off" when this is done, replace the valve.

*b. Leakage Test.* With normal air pressure in the system, coat the entire safety valve with a soap and water solution; check for bubbles indicating leakage. Leakage at the exhaust port should not exceed a 3-inch bubble in 3 seconds. If the safety valve leaks excessively, replace the valve.

*c. Removal.*

- (1) Open the drain cock (14) and allow the air system to drain.
- (2) Unscrew and remove the safety valve (17) from the air reservoir (11).

*d. Adjustment.*

- (1) Connect the safety valve in series with a known reliable pressure gage which reads to at least 200 psi and a variable pressure source of at least 160 psi.
- (2) Adjust the pressure source to obtain a reading of 150 psi on the pressure gage. At this point, the safety valve should not open; if air is escaping, loosen the nut and turn the adjusting nut in to increase the pressure setting.

**138. Air Reservoir**  
(fig. 83)

*a. Removal.*

- (1) Open the drain cock (14) and allow the air system to drain.
- (2) Disconnect the reservoir drain tube (13) from the elbow at the bottom of the air reservoir (11).
- (3) Disconnect the compressor-to-reservoir tube (16) and the reservoir-to-manifold tube (10) from the elbows on the ends of the air reservoir. Disconnect the reservoir-to-governor tube (19) from the fitting on the air reservoir.
- (4) Remove the four nuts and two U-bolts (12) that secure the air reservoir to the loader frame; remove the air reservoir.
- (5) Remove the safety valve (17) and fittings from the air reservoir.

*b. Cleaning and Inspection.*

- (1) Clean all grease and dirt from the

exterior of the air reservoir by wiping with a cloth dampened with an approved solvent. Pour solvent into the reservoir and shake vigorously to remove all deposits of oil from the reservoir. Drain and blow dry with compressed air.

- (2) Inspect the reservoir for cracks, stripped threads, corrosion, or other damage; repaint if required.
- (3) If the interior of the reservoir has an excessive coating of sludge, clean with steam and hot water.
- (4) Replace all damaged fittings or hardware.

*c. Installation.* Install the air reservoir by reversing the removal procedure given in *a* above.

**189. Double Check Valve**

*a. Removal.*

- (1) Remove the access cover (19, fig. 81) from the right side of the loader. From under the loader, disconnect the hand brake valve-to-double check valve tube (3, fig. 83) from the double check valve (6); disconnect the double check valve-to-service coupling tube (21) from the check valve.
- (2) Remove the double check valve (6) and fittings from the treadle valve (5); remove the fittings from the check valve.

*b. Cleaning and Inspection.*

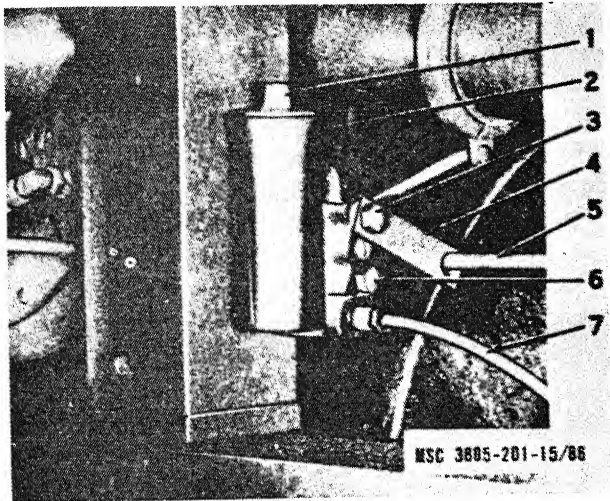
- (1) Clean the check valve with an approved solvent; dry thoroughly.
- (2) Inspect for cracks, stripped threads, or other damage; replace the check valve if defective in any way.

*c. Installation.* Install the double check valve by reversing the removal procedure given in *a* above.

**190. Hand Brake Valve**  
(fig. 83)

*a. Removal.*

- (1) Open the drain cock (14) and allow the air system to drain.
- (2) Tag and disconnect the manifold-to-handbrake valve tube (2), the handbrake valve-to-double check valve tube (3), and the handbrake valve exhaust



- |                           |                              |
|---------------------------|------------------------------|
| 1 Cover                   | 5 Accelerator rod            |
| 2 Air governor            | 6 Capscrew                   |
| 3 Capscrew                | 7 Reservoir-to-governor tube |
| 4 Accelerator rod bracket |                              |

Figure 86. Air governor installation.

tube (28) from the handbrake valve (1).

- (3) Remove the two capscrews, nuts, lockwashers, and the clamp that secure the brake valve mounting bracket and the brake valve to the steering column; remove and disassemble the bracket and valve.
- (4) Remove the fittings from the brake valve.

*b. Cleaning and Inspection.*

- (1) Wipe all dust and dirt from the parts with a clean cloth.
- (2) Inspect the hand brake valve for damage or defective operation.
- (3) Inspect the tubes and fittings for cracks, dents, stripped threads, or other defects.
- (4) Replace all unserviceable parts.

*c. Installation.* Install the handbrake valve by reversing the removal procedure described in *a* above.

## 191. Treadle Valve (fig. 83)

*a. Removal.*

- (1) Open the drain cock (14) and allow the air system to drain.

- (2) Remove the double check valve (6) as directed in paragraph 189a.
- (3) Disconnect the treadle valve-to-power cluster tube (7), manifold-to-treadle valve tube (26), and treadle valve-to-transmission tube (42) from the treadle valve (5).
- (4) Remove the three capscrews, nuts, and lockwashers that secure the treadle valve to the front floorboard; remove the treadle valve.
- (5) Remove the fittings from the treadle valve.

*b. Cleaning and Inspection.*

- (1) Wipe all parts with a cloth dampened with an approved cleaning solvent; dry thoroughly.
- (2) Inspect the treadle valve for damage or defective operation.
- (3) Inspect the tubes for cracks, kinks, stripped fittings, or other damage.
- (4) Replace all unserviceable parts.

*c. Installation.* Install the treadle valve by reversing the removal procedure described in *a* above.

## 192. Air Governor

*a. Adjustment.*

- (1) Remove the four capscrews (35, fig. 81), lockwashers (34), and flat washers (33) that secure the right side center panel (32) to the loader; remove the panel.
- (2) Remove the cover (1, fig. 86) from the air governor (2).
- (3) Build up reservoir pressure by starting the engine; note the pressure at which air starts to escape from the governor.
- (4) If the escape pressure is below 100 psi, loosen the nut that secures the adjusting screw; turn the adjusting screw clockwise. If the escape pressure is above 105 psi, loosen the nut and turn the adjusting screw counterclockwise.
- (5) When adjustment has been set between 100 and 105 psi, tighten the nut to lock the adjusting screw in position.
- (6) Install the cover on the air governor.
- (7) To check the air governor for leakage, coat the entire governor with soap suds while air pressure is being applied.

- (8) There should be no leakage; however, a 1-inch soap bubble at the exhaust vent in 3 seconds is permissible.

*b. Removal.*

- (1) Open the drain cock (14, fig. 83) and allow the air system to drain.
- (2) Remove the reservoir-to-governor tube (7, fig. 86) and the governor-to-compressor tube from the governor.
- (3) Remove the capscrew (3) and lock-washer that secure the accelerator rod bracket (4) to the air governor.
- (4) Remove the elbow and connector from the governor.

*c. Cleaning and Inspection.*

- (1) Wipe the parts with a cloth dampened with an approved cleaning solvent; dry thoroughly.
- (2) Inspect the air governor for visual damage.
- (3) Inspect the tubes and fittings for cracks, kinks, stripped threads, or other damage.
- (4) Replace all unserviceable parts.

*d. Installation.* Install the air governor by reversing the removal procedure described in *b* above.

### 193. Low Pressure Indicator (fig. 83)

*a. Removal.*

- (1) Open the drain cock (14) and allow the air system to drain.
- (2) Disconnect and tape the electrical leads to the low pressure indicator (23).
- (3) Disconnect the low pressure indicator-to-air pressure gage tube (24) and the manifold-to-low pressure indicator tube (25) from the low pressure indicator.
- (4) Remove the two capscrews and lock-washers that secure the low pressure indicator to the loader; remove the low pressure indicator. Remove the fitting from the low pressure indicator.

*b. Cleaning and Inspection.*

- (1) Clean the low pressure indicator by wiping with a cloth dampened in an approved solvent; dry thoroughly.
- (2) Inspect for cracks, stripped threads, or other damage.

- (3) Replace the low pressure indicator if it is defective.

*c. Installation and Test.*

- (1) Install the low pressure indicator by reversing the removal procedure given in *a* above.
- (2) Start the engine to build up pressure in the air system. When the ignition switch is turned on, the buzzer should sound and should continue to sound until the air pressure has increased to 54 to 66 psi. If the buzzer stops at too low or too high a pressure, replace the low pressure indicator.
- (3) Check the low pressure indicator for leakage by covering the small vent hole in the cover with a soap and water solution; replace the low pressure indicator if there is any leakage.

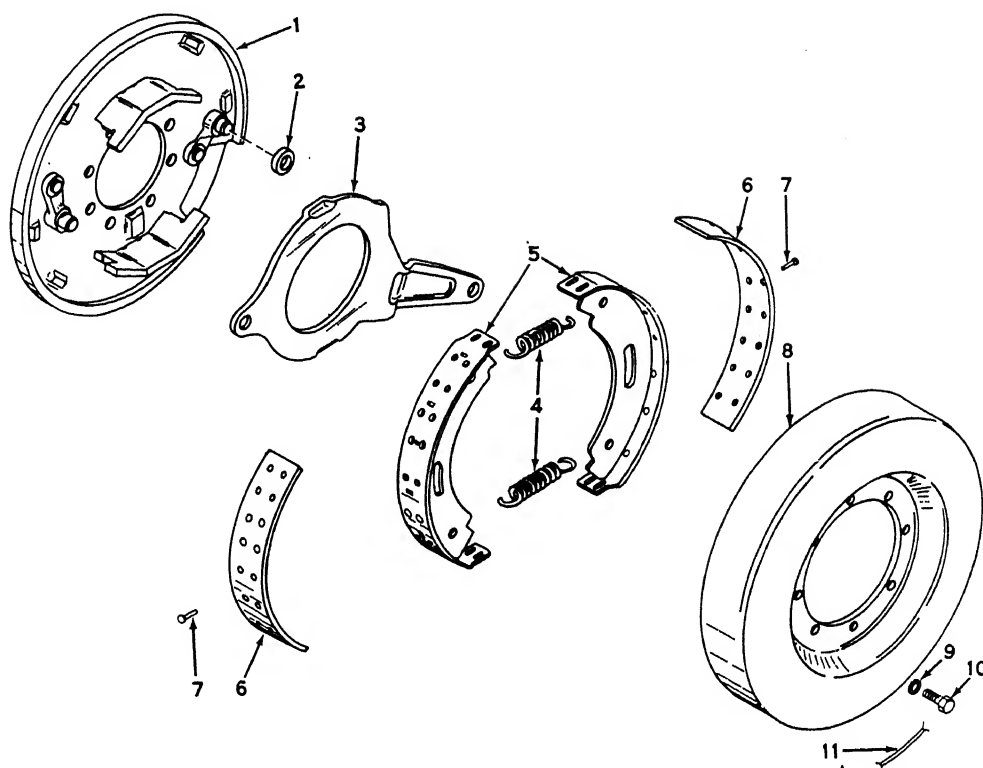
### 194. Emergency and Service Couplings .

*a. Removal.*

- (1) Disconnect the dummy couplings (38, fig. 83) from the service coupling (40) and emergency coupling (39).
- (2) Open the cutout cock (41) of the emergency coupling and allow the air pressure to exhaust from the air system.
- (3) Remove the service air coupling and the emergency coupling from the nipple assemblies.
- (4) Remove the capscrews, lockwashers, and flat washers that secure the nipple assemblies to the hood; remove the nipple assemblies, cutout cocks (41), nipples, and elbows.
- (5) Disconnect the double check valve-to-service coupling tube (21) and the emergency coupling-to-compressor outlet tube (37) from the elbows beneath the hood; remove the elbows.
- (6) Remove the two clamping studs, the service tag, and the emergency tag from the hood.

*b. Cleaning and Inspection.*

- (1) Wipe all parts with a cloth dampened with an approved solvent; dry thoroughly.
- (2) Inspect the parts for cracks, corrosion, stripped threads, excessive wear, or other damage.
- (3) Inspect the packing ring of the couplings for damage or deterioration.



MSC 3805-201-15/87

1 Brake backing plate  
2 Roller  
3 Lever

4 Spring  
5 Brake shoe  
6 Lining

7 Rivet  
8 Brake drum  
9 Lockwasher

10 Screw  
11 Lockwire

Figure 87. Parking brake, exploded view.

(4) Replace the packing and all unserviceable parts.

c. *Installation.* Install the emergency and service couplings by reversing the removal procedure described in subparagraph *a* above. Position the clamping studs and tags on the hood; the emergency tag goes on the right side and the service tag goes on the left side. Secure with the nuts of the clamping studs.

## 195. Air Compressor

### a. Removal.

- (1) Open the drain cock (14, fig. 83) and allow the air system to drain. Remove the large right side panel from the rear hood.
- (2) Remove the fuel pump as directed in paragraph 130c.
- (3) Remove the fuel filter assembly as directed in paragraph 129c.
- (4) Disconnect the air inlet tube and the compressor outlet tube (35) from the

air compressor; remove the governor-to-compressor tube (34) and the elbow from the air compressor.

- (5) Drain the engine cooling system as directed in paragraph 148b; disconnect the water inlet tube and water outlet tube (9, fig. 55) from the air compressor.
- (6) Remove the radiator from the loader as directed in paragraph 151a.
- (7) Loosen the tension and remove the fan drive belts (13, fig. 50) that drive the fan and generator from the accessory drive pulley.
- (8) Remove the screw, lockwasher, and flat washer that secure the accessory drive pulley to the compressor crankshaft; using a suitable puller, remove the accessory drive pulley and key.
- (9) Remove the screws and lockwashers that secure the air compressor to the

engine; remove the air compressor and gasket.

*b. Cleaning and Inspection.*

- (1) Plug or cover all openings on the air compressor; clean the exterior of the air compressor by brushing with an approved solvent; dry thoroughly.
- (2) Inspect the water inlet and outlet tubes and air tubes for cracks, dents, stripped threads, or other damage.
- (3) Inspect the fuel pump drive coupling for excessive wear or damage.
- (4) Check the air compressor for damage or defective operation.
- (5) Replace all gaskets and unserviceable parts.

*c. Installation.*

- (1) Remove the plug from the engine gear cover; have an assistant crank the engine slowly until the center punch timing mark can be observed through the hole.
- (2) Position the gasket and the air compressor on the engine so the timing mark on the drive gear aligns with the timing mark on the camshaft gear; secure with the screws and lockwashers.
- (3) Position the key on the air compressor crankshaft. Align the accessory drive pulley with the key and install on the air compressor crankshaft; secure with the screw, lockwasher, and flat washer.
- (4) Install the fan drive belts (13, fig. 50) that drive the generator and fan on the accessory drive pulley; adjust the tension as directed in paragraph 152e.
- (5) Install the radiator as directed in paragraph 151c.
- (6) Connect the water inlet tube and water outlet tube (9, fig. 55) to the air compressor; fill the engine cooling system as directed in paragraph 148a.
- (7) Install the elbows at the top and side of the air compressor cylinder head; connect the governor-to-compressor tube (34, fig. 83) to the elbow at the top of the cylinder head, and the compressor-to-reservoir tube (16) to the elbow at the rear of the cylinder head.

- (8) Connect the air inlet tube to the compressor air inlet connection.

- (9) Install the fuel pump as directed in paragraph 130e.

- (10) Install the large right side panel on the rear hood. Close the air system drain cock (14).

## **196. Parking Brake** (fig. 87)

*a. Removal and Disassembly.*

- (1) Disconnect the lower drive shaft from the transmission front output flange as directed in paragraph 217a.
- (2) Remove the cotter pin and clevis pin that secure the brake rod clevis to the lever; disconnect the brake rod.
- (3) Remove the lockwire (11), eight screws (10), and lockwashers (9) that secure the brake drum (8) to the transmission front output flange; remove the brake drum.
- (4) Remove the two springs (4) extending between the brake shoes; remove the brake shoes.
- (5) If the brake linings (6) require replacement, drill out the 14 rivets (7) that secure each lining to its brake shoe (5); remove the linings.
- (6) Remove the output flange from the transmission rear output shaft as directed in paragraph 217a.
- (7) Remove the lever (3) and the roller (2) from the brake backing plate (1).
- (8) If the brake backing plate (1) is damaged, remove it from the transmission housing.

*b. Cleaning and Inspection.*

- (1) Clean all metal parts with an approved solvent; dry thoroughly.
- (2) Thoroughly clean the brake shoes with a wire brush.
- (3) Inspect the brake drum for cracks and for scoring or roughness on its inner surface. If it is slightly scored or rough, turn down on a lathe; take light cuts and finish to a smooth surface. Do not remove any more metal than necessary.
- (4) Inspect all parts for cracks, breaks, distortion, corrosion, and other damage.



- (5) Inspect the brake shoe linings for grease spots, glazing, or excessive wear. If the heads of the rivets are close to the outer surface of the linings, replace the linings.
- (6) Inspect the springs for distortion or loss of tension.
- (7) Inspect the lever, roller, and actuating pawls for excessive wear or damage.

- (8) Inspect the output flange for cracks, stripped threads, damaged splines, or other defects.
- (9) Replace all unserviceable parts.

*Reassembly and Installation.* Reassemble and install the parking brake by reversing the removal and disassembly procedure given in *a* above.

### Section XIII. STEERING SYSTEM

#### 197. General (fig. 88)

The mechanical steering gear incorporates a hydraulic steering valve (8). When the operator's effort at the steering wheel exceeds the preload of the actuator centering springs, the control valve directs the oil pressure supplied by the smaller section of the main hydraulic pump (3) to the proper side of the two steering cylinders (2 and 14) to assist the manual linkage in turning the loader wheels. A relief valve (5) is connected into the hydraulic steering system to relieve excess pressure to the hydraulic reservoir which supplies the hydraulic oil. The manual linkage is through the steering rod from the pitman arm to the steering arm on the steering knuckle. A tie rod joins the two steering knuckles on the rear axle.

#### 198. Draining the Steering Hydraulic System (fig. 88)

- a.* Drain the reservoir and disconnect the hoses (6, 7, 9, 10, and 13) from the steering valve (8). Drain the hoses into a suitable container.
- b.* Disconnect the hoses (16 and 17) from the fittings on the steering cylinders (2 and 14). Drain the hoses into a suitable container.
- c.* To drain the steering cylinders, hoist the back of the loader so that the rear wheels are off the ground. With containers under the open ports of the steering cylinders, turn the steering wheel back and forth to eliminate fluid from the cylinders.
- d.* Disconnect and drain the pump-to-relief valve tube (4).
- e.* After draining, reconnect all hoses to prevent the entry of dirt into the system.

#### 199. Steering Gear Assembly

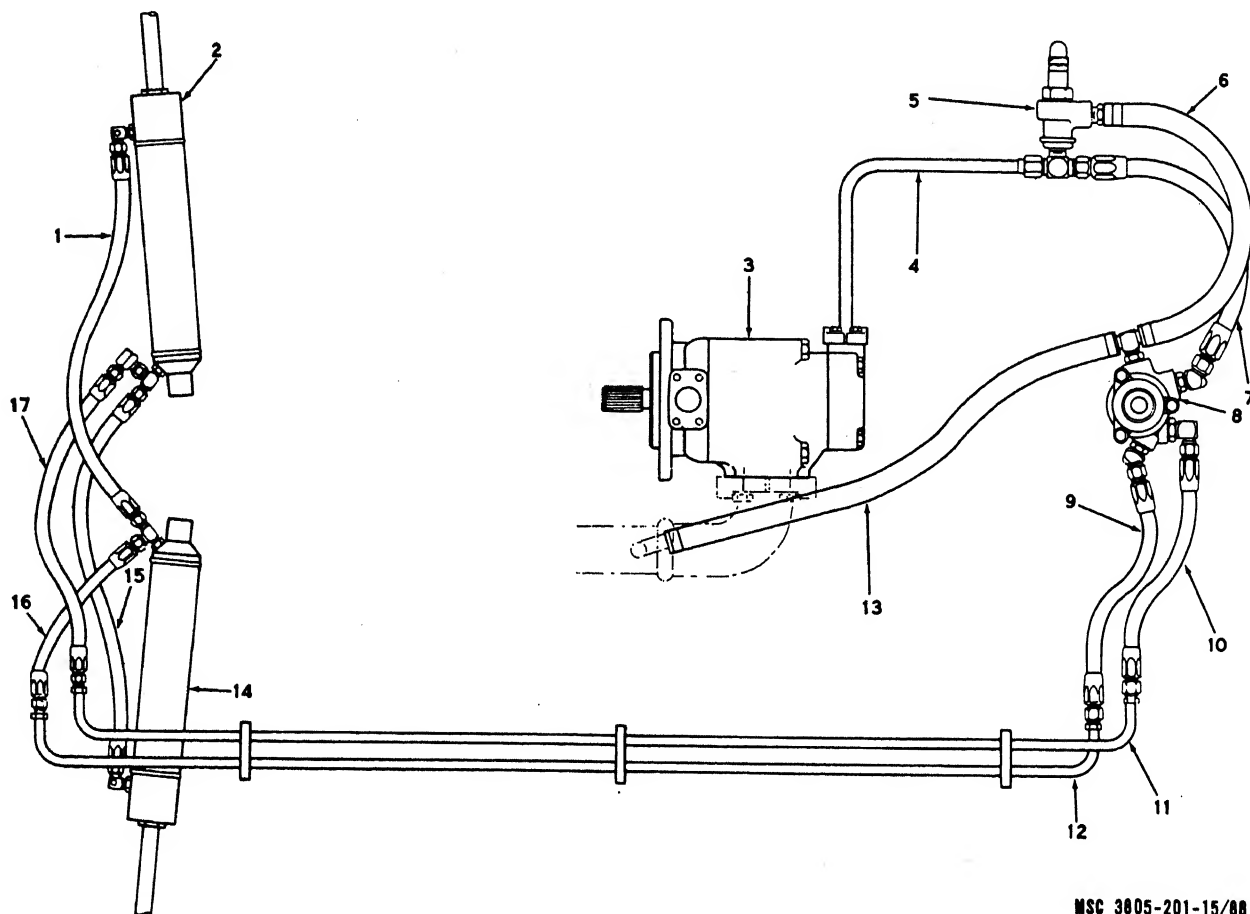
##### *a. Lash Adjustment* (fig. 89).

- (1) Disconnect the drag link from the pitman arm as directed in paragraph 200b.
- (2) Turn the steering wheel gently against a stop in one direction. Carefully count the number of turns required to turn the steering wheel against the stop in the other direction. Divide the total turns by two and turn the steering wheel back to the midposition. Mark the steering wheel at the top or bottom with a piece of tape.
- (3) Loosen the locking nut (3) on the thrust screw (4) which is opposite the pitman arm on the lower right side of the steering gear (5). Turn the screw so that the force required to move the rim of the steering wheel through a 3-inch arc is between  $1\frac{1}{4}$  and  $1\frac{1}{2}$  pounds. The rim pull through the entire steering gear range should be between  $1\frac{1}{8}$  and 2 pounds.
- (4) Install the drag link on the pitman arm as directed in paragraph 200d.

##### *b. Steering Alinement Adjustment.*

- (1) *Start the engine.* Turn the steering wheel so that the rear tires are straight ahead and in line with the front tires. Turn off the engine and apply the parking brake.
- (2) Disconnect the steering rod from the pitman arm of the steering gear as directed in paragraph 200b.
- (3) Turn the steering wheel as far as it will go in one direction; do not force the steering wheel when it reaches the limit of its travel. Then turn the steering wheel in the opposite direction,





MSC 3805-201-15/88

- |                               |                                       |                                     |                                     |
|-------------------------------|---------------------------------------|-------------------------------------|-------------------------------------|
| 1 Left-to-right cylinder hose | 6 Relief valve-to-steering valve hose | 10 Steering valve-to-tube hose      | 15 Left-to-right cylinder hose      |
| 2 Left cylinder               | 7 Relief valve-to-steering valve hose | 11 Left turn tube                   | 16 Right turn tube-to-cylinder hose |
| 3 Hydraulic pump              | 8 Steering valve                      | 12 Right turn tube                  | 17 Left turn tube-to-cylinder hose  |
| 4 Pump-to-relief valve tube   | 9 Steering valve-to-tube hose         | 13 Steering valve-to-reservoir hose |                                     |
| 5 Relief valve                |                                       | 14 Right cylinder                   |                                     |

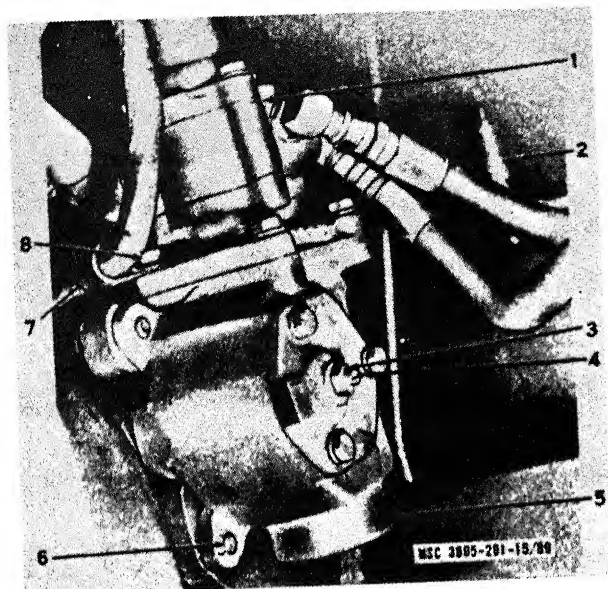
Figure 88. Steering system, schematic diagram.

carefully counting the total number of turns from stop to stop. Divide the total turns by two; turn the steering wheel that amount to center it at mid-position.

- (4) If the pitman arm (2, fig. 90) is aligned with the socket of the steering rod, reconnect it as directed in paragraph 200d. If the pitman arm and steering socket are not aligned, remove the nut and lockwasher that secure the pitman arm to the steering gear. Relocate the pitman arm to secure alignment; connect the drag link end as directed in paragraph 200d.
- (5) Measure the distance between the inside of the left and right rear tires,

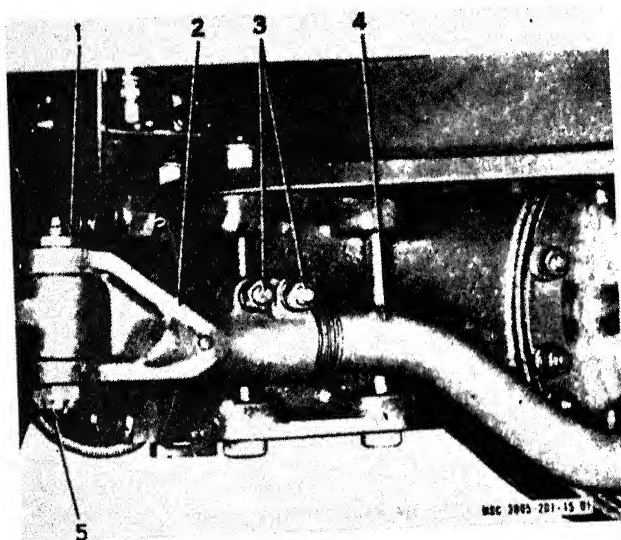
both toward the front and rear of the tires. The tires should be parallel without toe-in or toe-out.

- (6) If the rear wheels are not alined, loosen the capscrews, nuts (3, fig. 91), and lockwashers that clamp either of the rod ends (2) to the tie rod (4) that extends between the wheels in front of the steering axle. Remove the nut (5) and the pivot pin (1) that secure the same rod end to the tie rod arm on the axle. Turn the rod end to aline the rear wheels; then secure the rod end to the rod arm on the axle with the pivot pin and nut. Clamp the rod end to the tie rod with the capscrew, lock-



- |                           |                 |
|---------------------------|-----------------|
| 1 Steering valve          | 5 Steering gear |
| 2 Air system safety valve | 6 Capscrew      |
| 3 Locking nut             | 7 Cable clamp   |
| 4 Thrust screw            | 8 Capscrew      |

Figure 89. Steering gear installation.



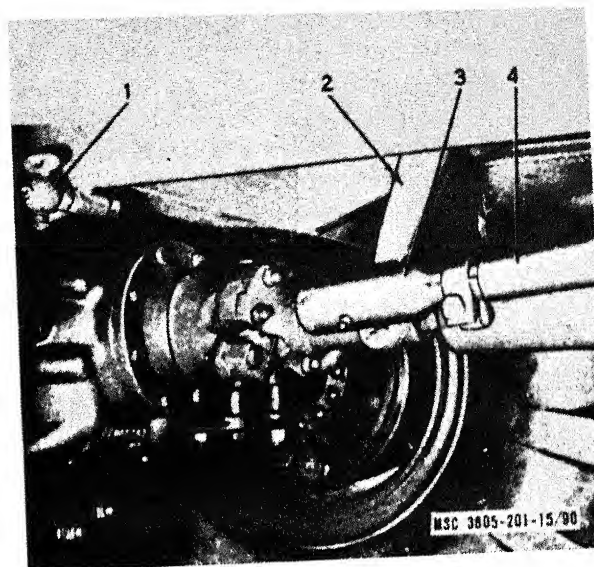
- |                            |                 |
|----------------------------|-----------------|
| 1 Air reservoir drain cock | 3 Drag link end |
| 2 Pitman arm               | 4 Drag link     |

Figure 90. Pitman arm and drag link installation.

washer, and nut. Recheck the rear wheel alignment.

#### c. Turning Radius Adjustment.

- (1) Check the alignment of the rear wheels as directed in *b* above; adjust if necessary.
- (2) Start the engine. Back up the loader at a very slow speed and make a hard

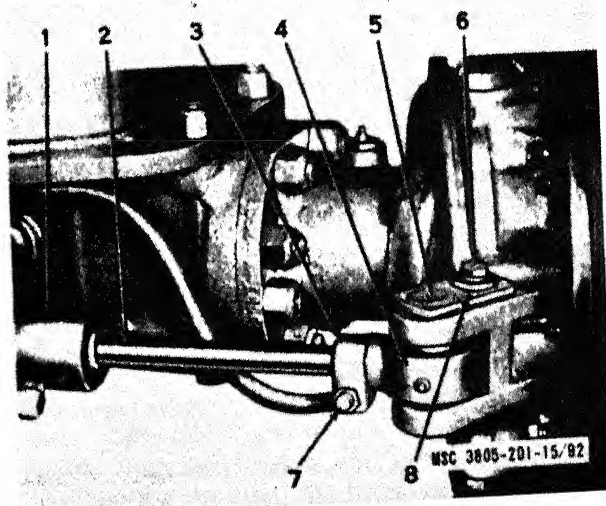


- |             |           |
|-------------|-----------|
| 1 Pivot pin | 4 Tie rod |
| 2 Rod end   | 5 Nut     |
| 3 Nut       |           |

Figure 91. Tie rod installation.

left turn. When the loader has turned 180°, stop the engine and apply the parking brake.

- (3) Carefully measure the horizontal angle between the inner side of a tire and the outside of the loader main frame; the angle should be 28 degrees.



- |                             |            |
|-----------------------------|------------|
| 1 Steering cylinder         | 5 Pinlock  |
| 2 Piston rod                | 6 Capscrew |
| 3 Clamp                     | 7 Capscrew |
| 4 Steering cylinder rod end | 8 Spacer   |

Figure 92. Steering cylinder installation.

- (4) If the angle between the inner side of the tire and the outside of the loader frame is not 28 degrees, remove the capscrew (6, fig. 92), lockwasher, and spacer (8) that secure the pinlock (5) to the steering arm; remove the pinlock and disengage the steering cylinder rod end (4) and spacer from the steering arm.
- (5) Loosen the capscrew (7) and nut that secure the clamp (3) to the piston rod (2). Turn the steering cylinder rod end (4) farther on or off the piston rod (2) as required to obtain the 28° measurement.
- (6) When the measurement is correct, tighten the capscrew (7) and nut against the steering cylinder rod end to secure the adjustment. Install the pinlock (5) with the capscrew (6), lockwasher, and spacer (8).
- (7) Start the engine and release the parking brake. Back up the loader at a very slow speed and make a hard right turn. When the loader has turned 180 degrees, stop the engine, apply the parking brake, measure the angle of the tire, and adjust the steering stop capscrew and steering cylinder, following the procedure in (3) through (6) above.
- (8) When the wheel alignment, steering stop capscrews, and steering cylinder have been adjusted, start the engine and operate the steering wheel as far as it will go from side to side. Be sure that the steering cylinder reaches the end of its travel before the steering gear reaches the end of its travel.

## 200. Drag Link

### a. Adjustment (fig. 93).

- (1) Remove the cotter pin (12) from the socket assembly that connects the drag link to the pitman arm of the steering gear.
- (2) Turn the adjusting plug (1) clockwise until all free play in the socket is eliminated; secure with the cotter pin.

### b. Removal and Disassembly.

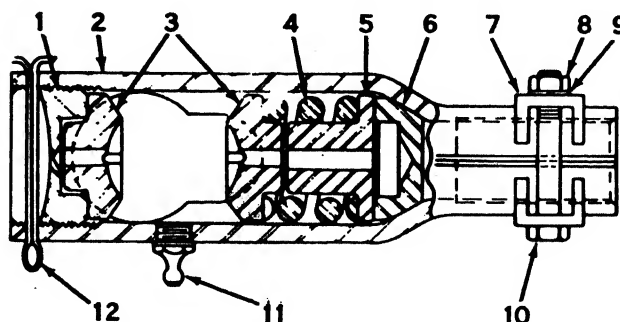
- (1) Remove the cotter pin (12, fig. 93) from the socket assembly that connects the front of the drag link to the

pitman arm; loosen the adjusting plug (1) and disconnect the socket assembly from the pitman arm.

- (2) Remove the cotter pin (11, fig. 94), nut (19), and spring (18) that secure the drag link socket assembly to the steering arm; disconnect the rear of the steering rod from the steering arm. If necessary, tap with a soft-headed hammer to loosen.
- (3) Remove the adjusting plug (1, fig. 93), two ball seats (3), spring (4), spring guide (5), and seat (6) from the socket housing at the front of the steering rod.
- (4) Remove the capscrew (10), nut (8), and lockwasher (9) that secure the clamp (7) to the pitman arm end of the drag link. Unscrew the socket housing (2) from the drag link.
- (5) Remove the two capscrews (13, fig. 94), nuts (15), and lockwashers (14) that secure the socket assembly housing (12) to the drag link; remove the socket assembly.
- (6) Remove the retaining ring (4), cap (5), spring (6), and washer (7) from the housing (12). Tap out the ball stud (10), sockets (8), and retainers (9). Remove the retainer (17) and felt washer (16).

### c. Cleaning and Inspection.

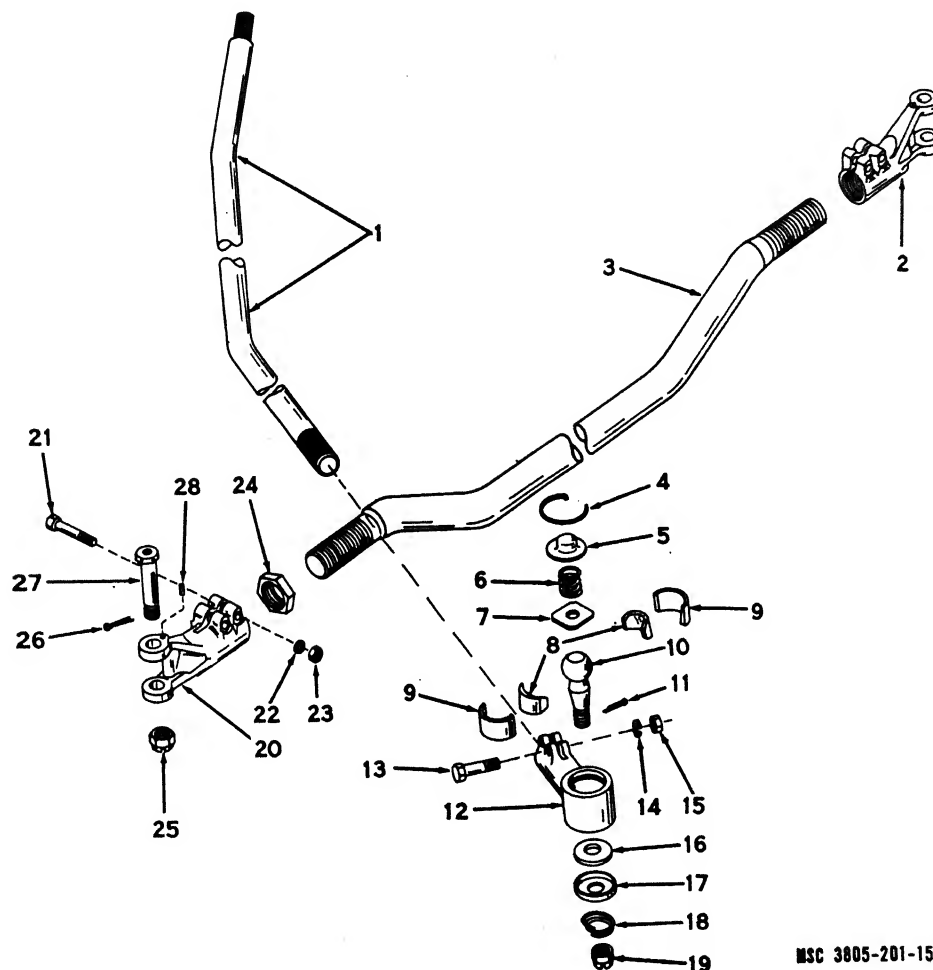
- (1) Clean all parts in an approved cleaning solvent; dry thoroughly.



MSC 3805-201-15/93

- |                  |                        |
|------------------|------------------------|
| 1 Adjusting plug | 7 Clamp                |
| 2 Socket housing | 8 Nut                  |
| 3 Ball seat      | 9 Lockwasher           |
| 4 Spring         | 10 Capscrew            |
| 5 Spring guide   | 11 Lubricating fitting |
| 6 Seat           | 12 Cotter pin          |

Figure 93. Steering rod socket and clamp, cross section.



MSC 3805-201-15/94

1 Drag link	8 Socket	15 Nut	22 Lockwasher
2 Yoke	9 Retainer	16 Felt washer	23 Nut
3 Tie rod	10 Ball stud	17 Retainer	24 Locknut
4 Retaining ring	11 Cotter pin	18 Spring	25 Castellated nut
5 Cap	12 Housing	19 Nut	26 Cotter pin
6 Spring	13 Capscrew	20 Yoke	27 Bolt
7 Washer	14 Lockwasher	21 Bolt	28 Pin

Figure 94. Tie rod and drag link, exploded view.

- (2) Inspect the parts for cracks, stripped threads, or excessive corrosion.
- (3) Inspect the bearing surfaces for excessive wear or scoring.
- (4) Replace all unserviceable parts.

*d. Reassembly and Installation.* Reassemble and install the drag link assembly by reversing the removal and disassembly procedure described in *b* above.

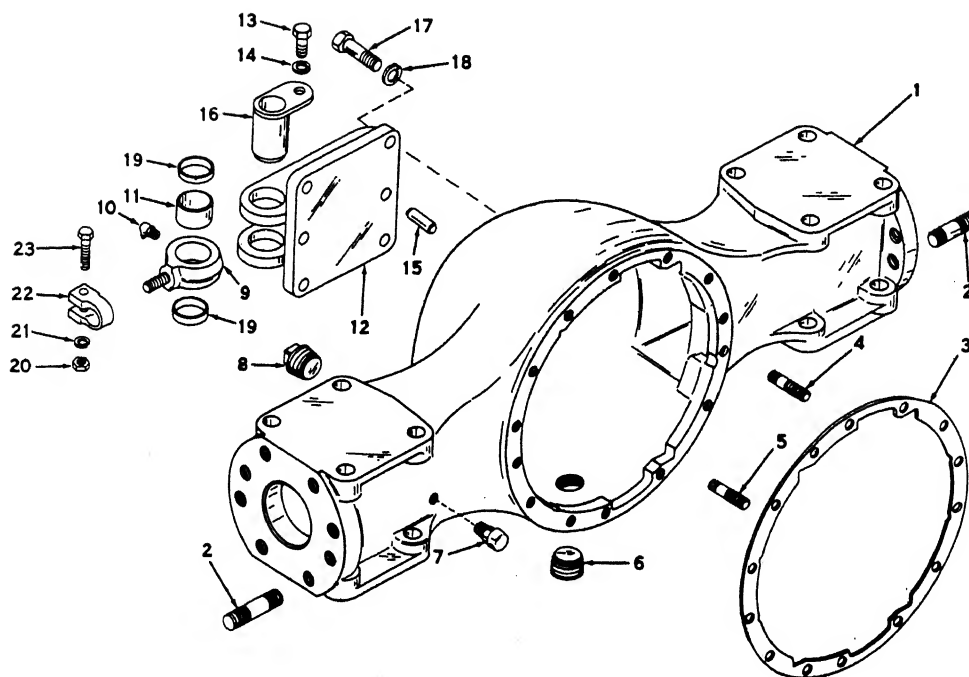
## 201. Steering Cylinder

### a. Removal.

- (1) Disconnect the hoses (1, 15, 16, and 17, fig. 88) from the steering cylinders.

Allow the hoses to drain into a container.

- (2) Remove the capscrew (6, fig. 92), lockwasher, and spacer (8) that secure the pinlock; remove the pinlock to release the steering cylinder (1) from the steering arm.
- (3) Remove the capscrew (13, fig. 95) that secures the pinlock (16) to the mounting plate (12) on the axle housing (1); drive out the pinlock.
- (4) Remove the assembled steering cylinder (1, fig. 92) and spacers (19, fig. 95) from the loader.



MSC 3805-201-15/95

1 Housing	7 Breather	13 Capscrew	19 Spacer
2 Stud	8 Pipe plug	14 Lockwasher	20 Nut
3 Gasket	9 Rod end	15 Pin	21 Lockwasher
4 Stud	10 Lubrication fitting	16 Pinlock	22 Clamp
5 Stud	11 Bushing	17 Capscrew	23 Capscrew
6 Plug	12 Mounting plate	18 Lockwasher	

Figure 95. Steering cylinder anchoring parts.

- (5) Remove the capscrew (7, fig. 92), nut, and lockwasher that secure the clamp (3) to the piston rod (2); turn the rod end from the piston rod and remove the clamp.
- (6) Remove the capscrew (23, fig. 95), nut (20), and lockwasher (21) that secure the clamp (22) to the cylinder end, from the cylinder. Remove the clamp.
- (7) Remove the hose fittings from each steering cylinder.

**b. Cleaning and Inspection.**

- (1) Clean the exterior of each steering cylinder with a cloth moistened with an approved cleaning solvent; dry thoroughly.
- (2) Clean all other parts in solvent; dry thoroughly.
- (3) Inspect the steering cylinders for cracks, dents, bent piston rods, and other damage. Manually operate the cylinder. The piston rod should move smoothly without binding.
- (4) Inspect the rod ends for cracks, worn or scored bushings (11, fig. 95), or

other damage. If the bushings are worn, press them out and press new bushings into the rod ends.

- (5) Inspect the hoses for cracks, cuts, deterioration, or other damage.
- (6) Inspect all other parts for cracks, worn threads, or other damage.
- (7) Replace all unserviceable parts.

**c. Installation.**

- (1) Install the steering cylinder by reversing the removal procedure described in *a* above.
- (2) Start the engine and turn the wheels back and forth several times to purge the air from the steering hydraulic system. Normal steering booster action should be obtained. Shut down the engine and check the level in the hydraulic reservoir. Fill if necessary.
- (3) Adjust the rod ends as directed in paragraph 200a.

**202. Relief Valve**

**a. Adjustment.**

- (1) Remove the left center panel from the

loader as directed in paragraph 182a(7).

- (2) Disconnect the relief valve-to-steering valve hose (7, fig. 88) and fitting leading to the tee just below the relief valve. Insert a tee in this line and reconnect the fitting and hose. Connect an accurate hydraulic gage with a rating of at least 3,000 psi to the tee so it can be observed by the operator.
- (3) Position the transmission and the boom and bucket and accessory control levers in neutral with the bucket resting on the ground; start the engine and allow it to run at idle speed until warmed up.
- (4) Speed up the engine slightly and observe the pressure gage while turning the steering wheel first in one direction and then in the other. The gage should register approximately 1,000 psi. If there is a significant variation, remove the cap nut (1, fig. 96) from the relief valve; loosen the nut (3) and turn the adjusting screw (2) in to increase the pressure, or out to decrease the pressure. Lock the adjustment with the nut and install the cap nut; recheck the pressure as above.
- (5) When the correct setting has been obtained, remove the pressure gage and the tee from the line; reinstall the relief valve-to-steering valve hose (7, fig. 88) and fitting.
- (6) Install the left center panel on the loader as directed in paragraph 182c.

**b. Removal.**

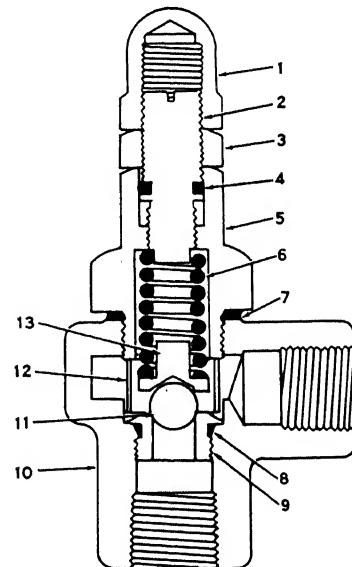
- (1) Remove the left center panel from the loader as directed in paragraph 182a(7).
- (2) Tag and disconnect the hoses (6 and 7, fig. 88) and tube (4). Plug the hoses and tube to prevent the loss of hydraulic oil or the entrance of foreign matter into the system.
- (3) Remove the two nuts and U-bolt that secure the relief valve to the loader frame; remove the relief valve.
- (4) Remove the fittings from the relief valve.

**c. Cleaning and Inspection.**

- (1) Wipe the relief valve with a cloth dampened with an approved cleaning solvent; dry thoroughly.
- (2) Inspect for cracks, stripped threads, or other damage.
- (3) Inspect the hose and tubes for cracks, cuts, deterioration, or other damage.
- (4) Replace all unserviceable parts.

**d. Installation.**

- (1) Install the fittings in the relief valve.
- (2) Position the relief valve and U-bolt on the loader frame; secure the relief valve with the two nuts. Remove the plugs and connect the hoses (6 and 7, fig. 88) and tube (4) to the appropriate fittings on the relief valve.
- (3) Check the fluid level in the hydraulic reservoir.
- (4) Adjust the relief valve as directed in *a* above.
- (5) Install the left center panel on the loader as directed in paragraph 182c.



MSC 3805-201-15/88

- |                     |                     |
|---------------------|---------------------|
| 1 Cap nut           | 8 Preformed packing |
| 2 Adjusting screw   | 9 Valve seat        |
| 3 Nut               | 10 Body             |
| 4 Preformed packing | 11 Ball             |
| 5 Cap               | 12 Seat jam collar  |
| 6 Spring            | 13 Spring guide     |
| 7 Gasket            |                     |

Figure 96. Steering relief valve, cross section.

## Section XIV MAIN HYDRAULIC SYSTEM

### 203. General

a. The main hydraulic system consists of a hydraulic reservoir (1, fig. 97), a two-section hydraulic pump (6), which supplies pressure for the main hydraulic system and for the hydraulic steering system; a hydraulic valve (32), two boom cylinders (13 and 28), one bucket cylinder (21), two bucket clam cylinders, and the necessary connecting hoses, tubes, and fittings. Hydraulic oil is drawn from the reservoir by the hydraulic pump which is driven by an accessory drive shaft. The oil is forced through a tube (7) to the control valve. When the valve control levers are in neutral position, the oil flows through the control valve back to the oil reservoir. When one of the valve control levers is moved, the oil is diverted through the tubes and hoses to the corresponding cylinders to actuate the cylinders and perform the desired motion. When the end of this motion or stroke is reached (piston rod is fully extended or retracted), the pressure buildup forces a plunger in the relief valve section of the control valve to open and return the excess oil to the reservoir.

b. Hydraulic oil is kept free of sediment, metal chips, and grit by a replaceable element filter mounted in the hydraulic reservoir.

### 204. Servicing the Main Hydraulic System

#### a. Checking Oil Reservoir Level.

- (1) Unscrew and remove the cap and dipstick assembly from the top of the oil reservoir. The correct oil level is at the H (high) mark of the dipstick. If required, add oil of the proper type and grade as specified on the lubrication order (fig. 27).
- (2) Install the cap and dipstick assembly on the oil reservoir.

#### b. Draining the System.

*Note.* Drain the system after operating the machine while the oil is still warm. Warm oil flows more freely and carries more dirt and sludge with it.

- (1) Start the engine, raise the boom to its full height, and adjust the bucket cylinder to the open position; securely chain or block the bucket and boom in this position and shut down the engine.
- (2) Remove the cap and dipstick assembly

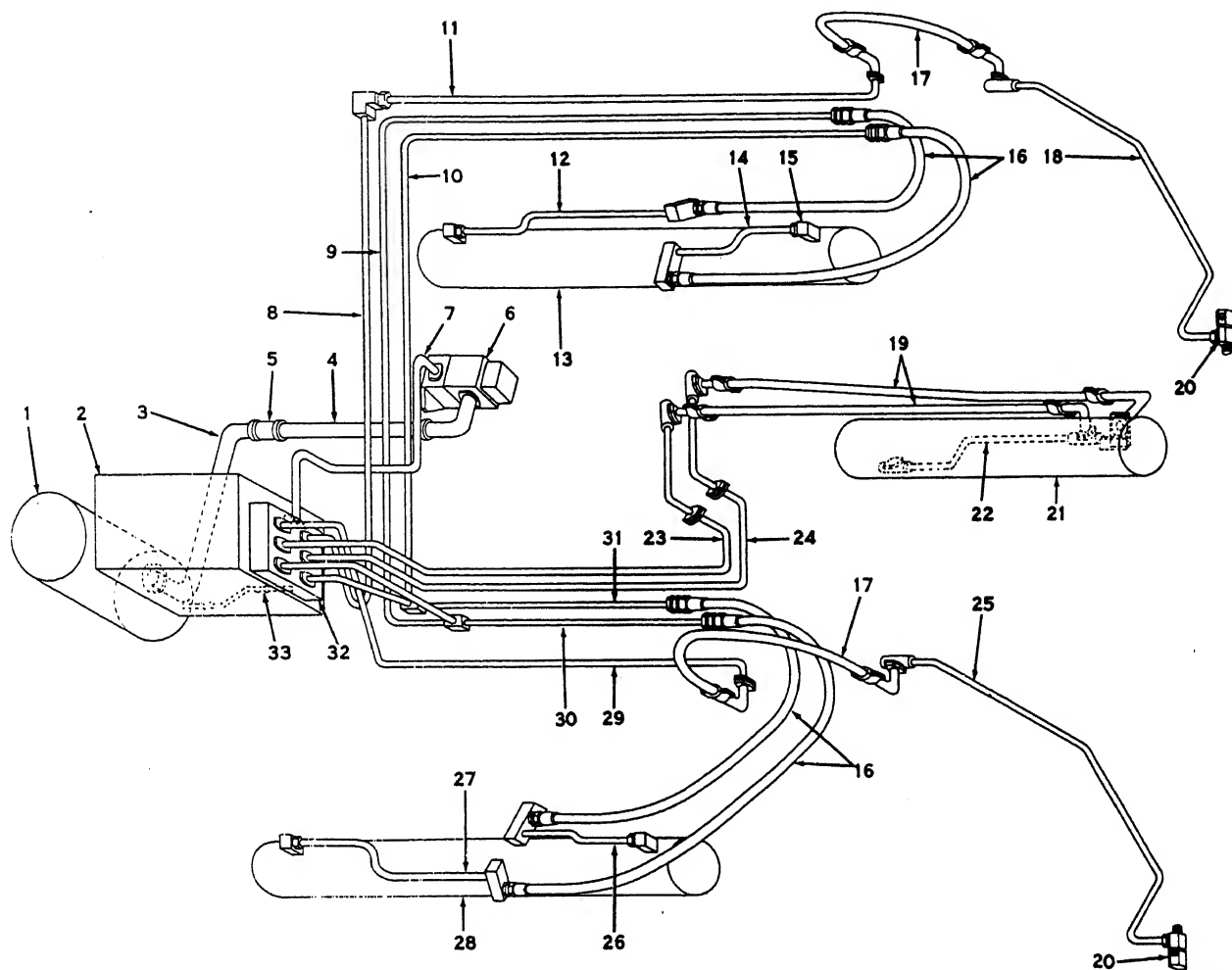
from the top of the oil reservoir.

- (3) Position the containers to catch the hydraulic oil.
- (4) Remove the drain plug from the bottom of the reservoir; use a funnel and hose to direct the flow to the container. Disconnect the pump tube (4, fig. 97) at the main hydraulic pump (6) and allow it to drain. Disconnect the boom and bucket cylinder hoses at the boom and bucket and accessory control levers to allow the oil to run out of the lines. Reconnect the hoses to prevent dirt from entering the system. Change the filter (par. 205). Clean the inside of the hydraulic reservoir, sediment trap (18, fig. 98), screen (12), and filler strainer (21). Reconnect the tube to the hydraulic pump. Install the drain plug in the reservoir bottom.
- (5) Drain the steering system as directed in paragraph 198.
- (6) Service the oil filter as directed in paragraph 203.

#### c. Filling the System.

- (1) Check that all hoses and tubes have been reconnected securely and that the drain plug at the bottom of the reservoir is secure.
- (2) Remove the cap and dipstick from the reservoir; fill the reservoir with the proper type of hydraulic oil as specified on the lubrication order (fig. 27).
- (3) Start the engine and allow it to run at idle speed with the control valve levers in neutral position. Add hydraulic oil to bring the level to the H (high) mark on the dipstick.
- (4) Operate the boom control lever to the RAISE position to pump oil into the boom cylinders; operate the bucket and accessory control lever to the CLOSE position. Check for oil leaks at the connection to the pump, cylinders, and control valve.
- (5) Check the hydraulic oil level and add oil as required.
- (6) Remove the chains or blocks supporting the boom and bucket, but do not work or stand under the boom or





MSC 3805-201-15/97

1 Hydraulic reservoir	10 Tube	18 Tube	26 Tube
2 Hydraulic manifold	11 Tube	19 Hose	27 Tube
3 Tube	12 Tube	20 Swivel connector	28 Boom cylinder
4 Tube	13 Boom cylinder	21 Bucket cylinder	29 Tube
5 Coupling	14 Tube	22 Tube	30 Tube
6 Hydraulic pump	15 Adjustable elbow	23 Tube	31 Tube
7 Tube	16 Hose	24 Tube	32 Hydraulic valve
8 Tube	17 Hose	25 Tube	33 Tube
9 Tube			

Figure 97. Main hydraulic system, schematic diagram.

bucket when the support has been removed.

- (7) Operate the boom and bucket and accessory control levers several times to bleed the air from the system; turn the steering wheel all the way in each direction several times to fill the hydraulic steering system.
- (8) After all air has been expelled from the system, add hydraulic oil to the reservoir to bring the level to the H (high) mark of the dipstick.

## 205. Servicing the Hydraulic Reservoir (fig. 98)

a. Every 1,000 hours of operation, or more frequently under unusually dirty operating conditions, drain the hydraulic system and replace the oil filter as follows:

- (1) Loosen the coupling (23) and remove the top (1) from the hydraulic reservoir.
- (2) Remove the three nuts (5) and lockwashers (4) that secure the flange (6)



to the studs (15); remove the flange and spring (7) and lift out the filter (19). Discard the filter.

- (3) Position the new filter in the reservoir. Position the flange and spring on the filter; secure with the three nuts (5) and lockwashers (4).
- (4) Install the top (1) and tighten the coupling (23) to secure it to the reservoir.

b. Every 1,000 hours of operation, or more frequently under unusually dirty operating conditions, remove the breather filter assembly (8) and wash it out with an approved cleaning solvent; shake out the solvent from the breather and reinstall. Replace the breather filter assembly if it is badly clogged.

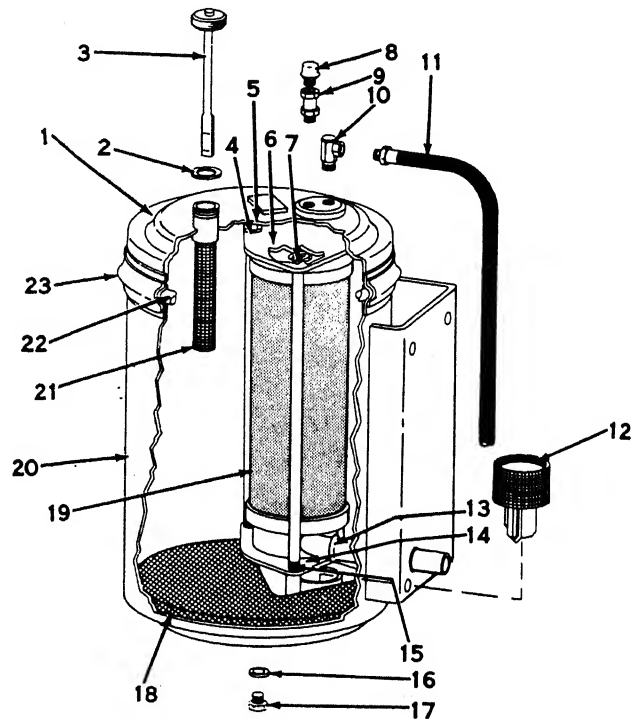
## 206. Main Hydraulic Pump

### a. Removal.

- (1) Drain the main hydraulic system as directed in paragraph 204b.
- (2) Remove the four capscrews and lockwashers that secure the split flanges and reservoir-to-pump tube (4, fig. 97) to the pump; remove the split flanges, disconnect the tube, and remove the preformed packing from the inlet.
- (3) Remove the four capscrews and lockwashers that secure the split flanges and pump tube (7) to the pump; remove the split flanges, disconnect the tube, and remove the preformed packing from the pump outlet.
- (4) Remove the four capscrews and lockwashers that secure the split flanges and pump-to-relief valve tube (4, fig. 88); remove the split flanges, disconnect the tube, and remove the preformed packing from the pump outlet.
- (5) Remove the two capscrews and lockwashers that secure the pump to the adapter plate; remove the pump.
- (6) Remove the four capscrews and lockwashers that secure the adapter plate to the transmission; remove the adapter plate.

### b. Cleaning and Inspection.

- (1) Cover the openings of the main hydraulic pump to prevent dirt or other foreign matter from entering. Wipe all dirt and grease from the exterior of the pump with a cloth dampened



MSC 3805-201-15/98

1 Top	12 Screen
2 Dipstick seal	13 Coupling
3 Dipstick oil gage	14 Filter manifold
4 Lockwasher	15 Stud
5 Nut	16 Preformed packing
6 Flange	17 Drain plug
7 Spring	18 Sediment trap
8 Breather filter assembly	19 Filter
9 Vacuum breaker	20 Reservoir bottom
10 Check valve	21 Filler strainer
11 Hose	22 Preformed packing
	23 Coupling

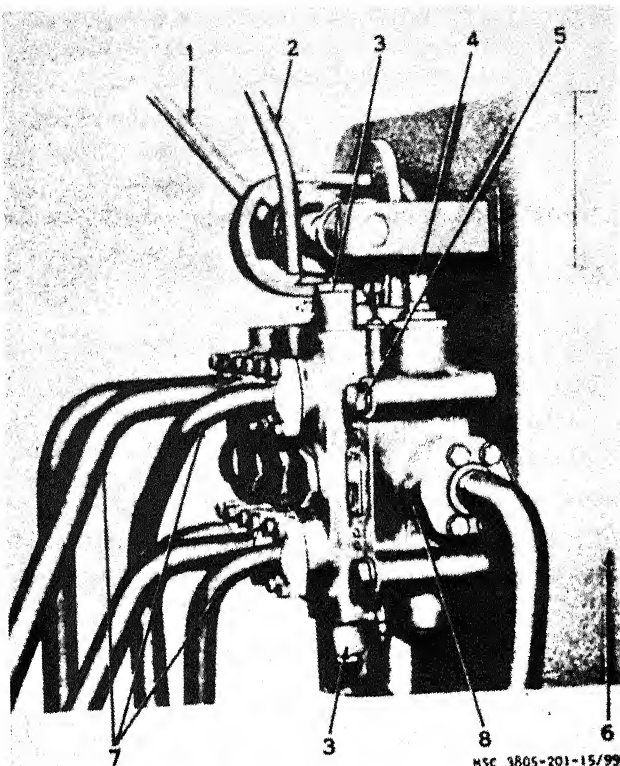
Figure 98. Hydraulic reservoir, exploded view.

with an approved cleaning solvent; dry thoroughly.

- (2) Inspect the pump for cracks or damage. Rotate the drive shaft of the pump to check for binding or catching operation; replace if damaged.
- (3) Inspect the hoses and tubes for cracks, deterioration, or other damage; replace damaged hoses and tubes.
- (4) Replace the preformed packings and all unserviceable parts.

### c. Installation.

- (1) Install the main hydraulic pump by reversing the removal procedure described in a above.
- (2) Fill the main hydraulic system as directed in paragraph 204c.



- |                                      |                      |
|--------------------------------------|----------------------|
| 1 Boom control lever                 | 5 Capscrew           |
| 2 Bucket and accessory control lever | 6 Hydraulic manifold |
| 3 Relief valve                       | 7 Tube               |
| 4 Main relief valve                  | 8 Pipe plug          |

Figure 99. Hydraulic control valve installation.

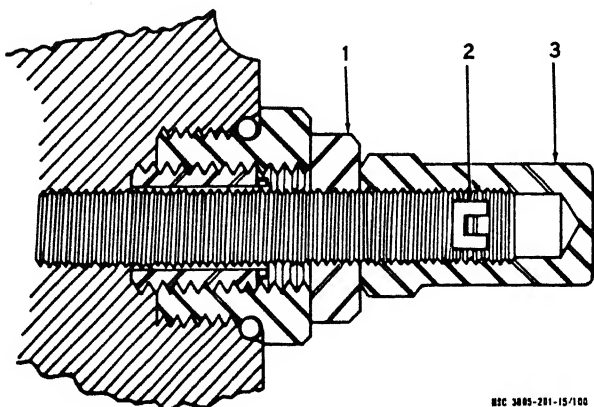
## 207. Hydraulic Control Valve

*a. Relief Valve Adjustment.* Adjust the relief valves on the hydraulic control valve as follows:

- (1) Remove the pipe plug (8, fig. 99) from the housing of the hydraulic control valve and install a hydraulic pressure gage capable of reading 3,000 psi.
- (2) Start the engine and leave the directional shift lever in neutral. Move the boom control lever to the RAISE position and depress the foot throttle to speed up the engine. Check the pressure indicated on the gage while the bucket is moving. It should read 1,800 psi.
- (3) If it does not read 1,800 psi, remove the capnut (3, fig. 100), loosen the locknut (1), and turn the adjustment screw (2) clockwise to increase pressure and counterclockwise to decrease pressure, using a screwdriver. Tight-

en the locknut and recheck the adjustment; readjust if necessary. With the bucket raised midway, move the boom control lever to the FLOAT position.

- (4) Move the bucket and accessory control lever forward to the DUMP position or to the rear to the ROLL BACK position and depress the foot throttle to speed up the engine. While the bucket is in motion, check the reading of the hydraulic pressure gage. It should be 2,000 psi. If it is not, shut off the engine and remove the plug from the upper relief valve (3, fig. 99). Add a shim or shims, as required, on top of the spring to increase the pressure. Install the plug on the relief valve.
  - (5) Start the engine and move the bucket and accessory control lever to either side to the clam OPEN or clam CLOSE position. Depress the foot throttle and while the clam is operating, check the indication on the hydraulic pressure gage. It should read 2,200 psi. If it does not, stop the engine and remove the plug from the lower relief valve (3); insert a shim or shims, as required, to achieve the correct reading. Adding shims increases the pressure. Install the plug in the relief valve.
  - (6) Restart the engine and recheck the adjustments of the relief valve pressures. If they are not correct, readjust as required.
  - (7) Stop the engine after the adjustments are completed and remove the hydraulic pressure gage from the port in the control valve housing. Replace the pipe plug (8, fig. 99).
- b. Removal.*
- (1) Drain the hydraulic reservoir as directed in paragraph 204b.
  - (2) Remove the boom and bucket and accessory control linkages as directed in paragraph 174a.
  - (3) Disconnect the hydraulic-valve tube (7, fig. 97) from the hydraulic valve (32); remove the adapter and preformed packing from the valve.
  - (4) Disconnect the tubes from the hydraulic valve; remove the adapter and preformed packing for each tube from the valve.



- 1 Locknut  
2 Adjustment screw  
3 Capnut

Figure 100. Main control valve pressure adjustment.

- (5) Remove the four valve mounting cap-screws (5, fig. 99) and lockwashers that secure the main hydraulic valve to the manifold enclosure; carefully remove the valve.
- (6) Remove the preformed packing from the back of the valve.

*c. Cleaning and Inspection.*

- (1) Clean the exterior of the main hydraulic valve with a cloth dampened with an approved cleaning solvent; dry thoroughly.
- (2) Check the main hydraulic valve for cracks, worn or damaged threads, and leaks. Manually operate the spools of the valve to check for binding or sticking operation.
- (3) Replace all preformed packings and unserviceable parts.

*d. Installation.*

- (1) Install the main hydraulic valve by reversing the removal procedure given in *b* above. Be sure to install the preformed packing in the back of the valve.
- (2) Fill the hydraulic reservoir as directed in paragraph 204c.

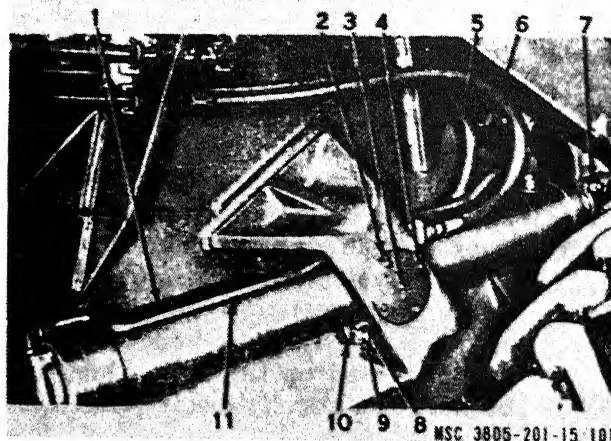
## 208. Boom Cylinder (fig. 101)

*a. Removal.*

- (1) Rest the bucket securely on the ground.
- (2) Disconnect the hoses (5 and 6) from their fittings. Plug the openings to

prevent dirt or other foreign matter from entering the hydraulic system. Drain the hoses into a container.

- (3) Disconnect the boom-cylinder tubes (11) from the boom cylinders; remove the fittings from the cylinders.
- (4) Remove the four capscrews (4) and lockwashers that secure each cover plate (2) to the main frame; remove the cover plates and gaskets.
- (5) Remove the capscrews, lockwashers, and flat washers that secure the pinlock to the boom; make sure that each boom cylinder is securely supported. Remove the pinlock and preformed packings from the boom.
- (6) Remove the capscrews, lockwashers, and nuts (8) that secure the mounting angle and the boom cylinder to the trunnion (10); remove the mounting angle from the cylinder.
- (7) Loosen the nuts (9) on the four cap-screws that secure the two halves of each trunnion to the boom cylinder; carefully slide each boom cylinder from its trunnion. Drain the hydraulic oil from the cylinders.
- (8) Remove the four capscrews, lockwashers, and nuts (9) that secure the trunnion halves to each other; remove



- |                       |                    |
|-----------------------|--------------------|
| 1 Boom cylinder       | 7 Rod end          |
| 2 Cover plate         | 8 Self-locking nut |
| 3 Lubrication fitting | 9 Nut              |
| 4 Capscrew            | 10 Trunnion        |
| 5 Hose                | 11 Tube            |
| 6 Hose                |                    |

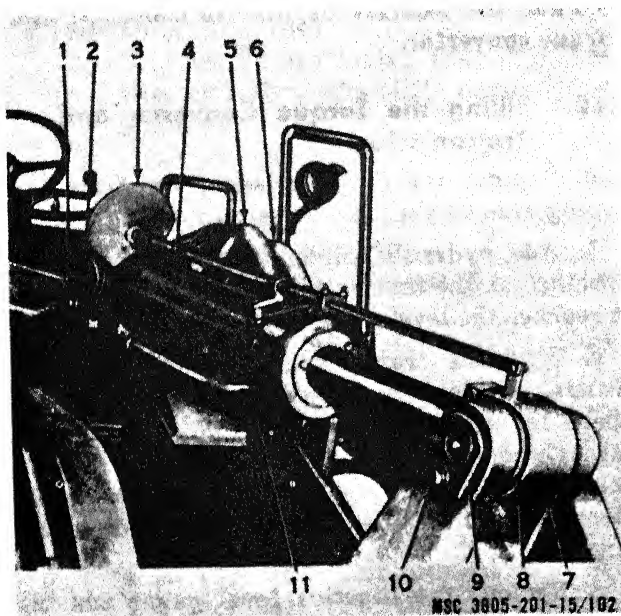
Figure 101. Boom cylinder mounting.

the trunnion and two preformed packings from each trunnion.

- (9) Remove the lubrication fittings (3) from the cover plates.

*b. Cleaning and Inspection.*

- (1) Clean the exterior of the boom cylinder with a cloth dampened with an approved cleaning solvent; dry thoroughly.
- (2) Inspect the boom cylinders for cracks, dents, distortion, or evidence of leaking. Check the operation of the cylinders to make sure the pistons and rods move freely without binding in the cylinders.
- (3) Inspect the hoses and tubes for cracks, abrasions, deterioration, or other damage.
- (4) Check the piston rod bushings; the trunnion bushings, and the working surfaces of the pinlocks for scoring and wear.
- (5) Replace all preformed packings, gaskets, and unserviceable parts.
- (5) Replace all preformed packings, gaskets, and unserviceable parts.



- |                             |                     |
|-----------------------------|---------------------|
| 1 Capscrew                  | 6 Hose              |
| 2 Pinlock                   | 7 Rod end           |
| 3 Bucket position indicator | 8 Preformed packing |
| 4 Bucket cylinder           | 9 Pinlock           |
| 5 Hose                      | 10 Capscrew         |
|                             | 11 Tube             |

*Figure 102. Bucket cylinder installation.*

the removal procedure described in *a* above.

- (2) Start the loader and check for proper operation of the boom cylinders; inspect for leakage at the hose and tube connections.
- (3) Check the oil level of the hydraulic reservoir as directed in paragraph 204a.

## 209. Bucket Cylinder (fig. 102)

*a. Removal.*

- (1) Rest the bucket securely on the ground.
- (2) Disconnect the bucket-cylinder hoses (5 and 6) and bucket-cylinder tube (11) from the bucket cylinder (4); remove the fittings from the bucket cylinder.
- (3) Remove the bucket position indicator as directed in paragraph 220.
- (4) Remove the capscrews (1 and 10), lockwashers, and flat washers that secure the pinlocks (2 and 9) at both ends of the bucket cylinder.
- (5) Be sure that the bucket cylinder is securely supported; drive the pinlocks (2 and 9) from the cylinder. Remove the bucket cylinder from the loader; remove the preformed packings (8) from both ends of the cylinder. Drain the hydraulic oil from the bucket cylinder.

*b. Cleaning and Inspection.*

- (1) Clean the exterior of bucket cylinder with a cloth dampened with an approved cleaning solvent; dry thoroughly.
- (2) Check the bucket cylinder for cracks, dents, distortion, or evidence of leaking. Check the operation of the cylinder to make sure the piston and rod move fully without binding in the cylinder.
- (3) Check the bushing ends of the cylinder and the working surfaces of the pinlocks for excessive wear or scoring.
- (4) Inspect the hoses, tubes, and fittings for cracks, stripped threads, deterioration, or other damage.
- (5) Replace all preformed packings and unserviceable parts.

*c. Installation.*

- (1) Install the bucket cylinder by reversing the removal procedure given in *a* above.
- (2) Start the loader and check the opera-

tion of the bucket cylinder; inspect for leakage at the connections.

- (3) Check the oil level of the hydraulic reservoir as directed in paragraph 204a.

## Section XV. TORQUE CONVERTER AND TRANSMISSION HYDRAULIC SYSTEM

### 210. General (fig. 103)

*a.* The torque converter and transmission hydraulic system supplies the hydraulic oil for charging the torque converter, operating the transmission clutch assemblies, and lubricating the torque converter and transmission parts. Oil as drawn from the transmission sump by the torque converter charging pump, which is mounted on the transmission and driven by the accessory drive shaft. After being placed under pressure, the oil is directed through passages in the transmission housing to the transmission control valve. A relief valve maintains a pressure of 150 psi for operation of the clutch assemblies. Part of the oil is directed to the torque converter, where a reduced pressure is maintained, and another relief valve reduces the pressure of the oil used for lubrication of the transmission to 25 to 40 psi.

*b.* An oil cooler (13) is mounted between the grille and radiator to cool the hydraulic oil and maintain proper operating temperatures in the torque converter and transmission.

*c.* An oil filter (10) is connected in the return line from the oil cooler to help keep the oil free of grit, metallic particles, and other abrasive material.

### 211. Draining the Torque Converter and Transmission (fig. 103)

*a.* Drain and refill the torque converter and transmission system every 1,000 hours under normal operating conditions. If the loader is operated under unusually dusty and dirty conditions, drain and refill the unit at more frequent intervals.

*Note.* Drain the unit only after the loader has been operated and the oil is still warm. Oil that is at least 145° F. will flow better and carry more dirt and sludge with it. Be sure to open the oil cooler drain cock when draining and filling the system.

*b.* Position suitable containers beneath the

torque converter and transmission and the oil cooler drain (14).

*c.* Remove the pipe plug from the oil cooler; drain and open the vent cock (1) at the top left side of the oil cooler. Remove the magnetic drain plug from the bottom of the transmission housing. An excessive accumulation of metal particles is evidence of part failure and necessity of overhaul. Remove the filler and level plug from the transmission.

*d.* Service the oil filter (10) as directed in paragraph 155a.

*e.* After allowing the system to drain for at least 30 minutes, install the drain plug into the transmission housing, and the plug in the oil cooler. Do not close the vent cock (1) on the oil cooler until after the system has been filled.

**Caution:** Never use flushing oil or solvents to flush the interior of the transmission and torque converter.

### 212. Filling the Torque Converter and Transmission

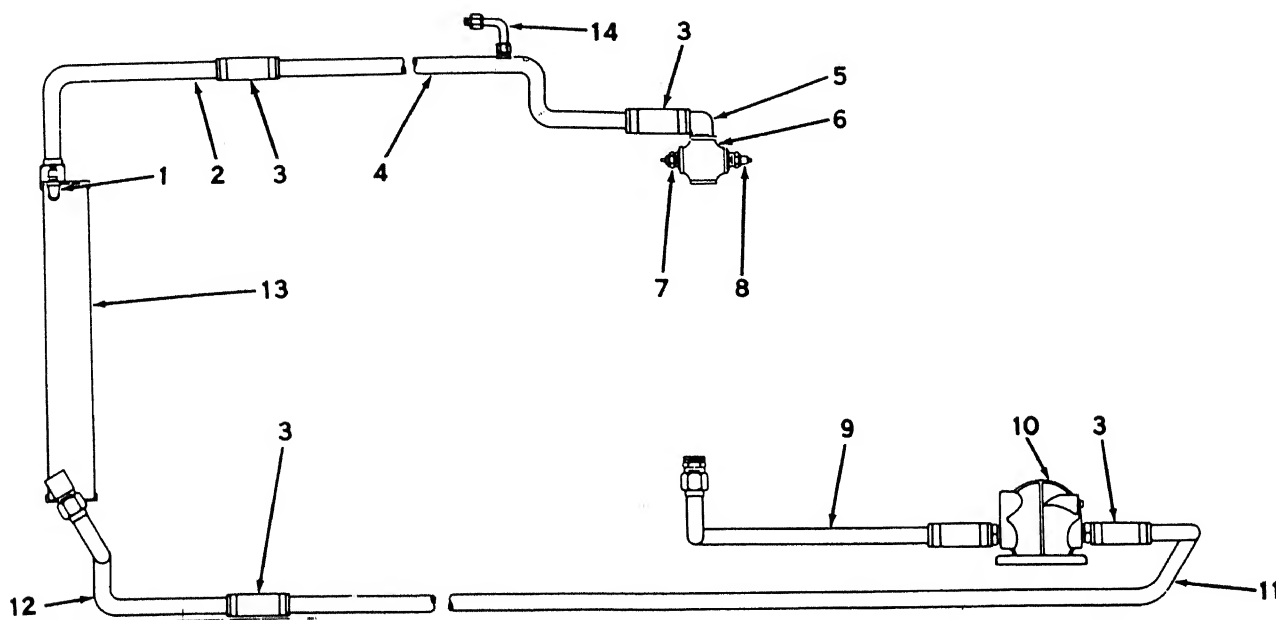
*a.* Remove the dipstick level gage from the piping side of the transmission housing.

*b.* Add hydraulic oil of the proper type as specified on the lubrication order (fig. 27) until it reaches the level mark on the gage.

*c.* With the transmission control levers at neutral position, start the engine and run at idle speed for about 2 minutes. Hold a clean container under the vent cock (1, fig. 103). Close the vent cock on the oil cooler when a steady stream of oil is discharged. Shut down the engine.

*d.* Remove the dipstick level gage; add oil until its level again reaches the full mark. Restart the engine and allow it to run for several minutes.

*e.* Recheck the oil level and add oil as required. Check for oil leaks at the oil cooler, oil filter, and transmission.



MSC 3805-201-15/103

1 Vent cock	5 90° nipple	8 Torque converter temperature switch	11 Tube
2 Tube	6 Cross	9 Tube	12 Tube
3 Hose	7 Torque converter temperature sender	10 Transmission oil filter	13 Oil cooler
4 Tube			14 Oil cooler drain

Figure 103. Torque converter and transmission hydraulic system, schematic diagram.

## 213. Torque Converter and Transmission Oil Filter

### a. Servicing (fig. 104).

- (1) Remove the drain plug (14) from the filter and allow the oil to drain into a container
- (2) Unscrew the assembled center stud (3) and shell (1) from the filter base (2); remove the assembly and gasket (4) from the filter base.
- (3) Remove the filter element (9) from the shell (1).
- (4) Clean the inside of the shell (1) with a clean cloth.
- (5) Place a new filter element (9) into position on the center stud (3) within the shell (1); install a new gasket (4) into the base (2).
- (6) Install the assembled center stud (3), shell (1), and filter element (9) into the filter base (2); tighten each stud to 50 plus or minus 5 foot-pounds torque.
- (7) Install the drain plug (14) into the filter.

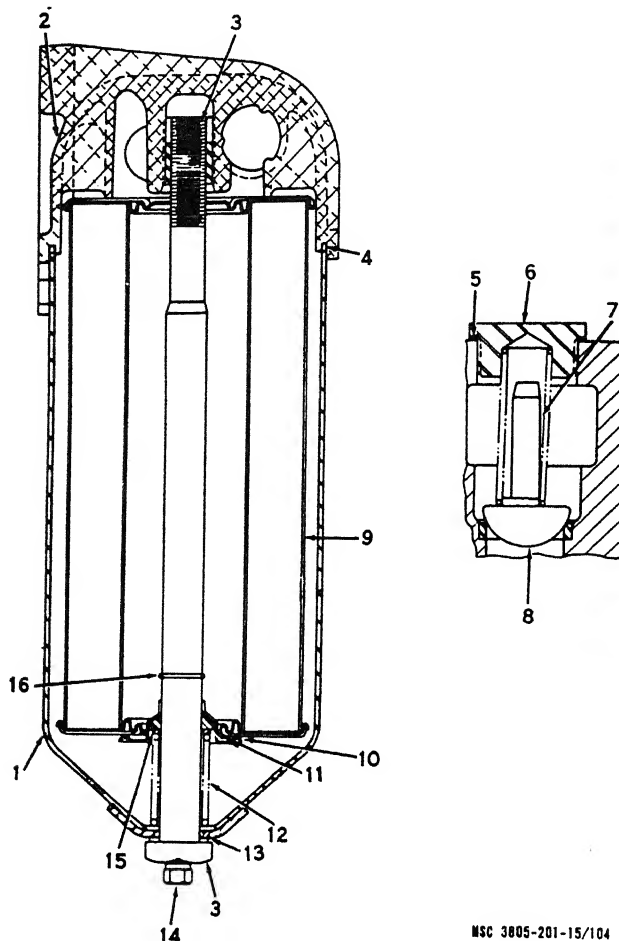
### b. Removal and Disassembly.

- (1) Remove the drain plug (14) from the

filter and allow the oil to drain into a strainer.

- (2) Remove the inlet and outlet hoses (3, fig. 103) from the filter and allow the oil to drain into a container.
- (3) Remove the four capscrews, nuts, and lockwashers that secure the filter to the loader; remove the filter from the loader. Remove the fittings from the filter inlet and outlet.
- (4) Unscrew the assembled center stud (3, fig. 104) and shell (1) from the filter base (2); remove the assembly and gasket (4) from the filter base.
- (5) Remove the filter element (9) from the shell (1).
- (6) Remove the retaining ring (16) from the center stud (3); remove the element retainer (10), stud gasket (11), stud washer (15), and spring (12) from the center stud.
- (7) Remove the center stud (3) and stud gasket (13) from the shell (1).
- (8) Remove the valve plug (6) and gasket (5) from the filter base (2); remove the valve spring (7) and bypass valve (8) from the filter base.





- |                     |                     |
|---------------------|---------------------|
| 1 Shell             | 9 Filter element    |
| 2 Base              | 10 Element retainer |
| 3 Center stud       | 11 Stud gasket      |
| 4 Base gasket       | 12 Spring           |
| 5 Valve-plug gasket | 13 Stud gasket      |
| 6 Valve plug        | 14 Drain plug       |
| 7 Valve spring      | 15 Stud washer      |
| 8 Bypass valve      | 16 Retaining ring   |

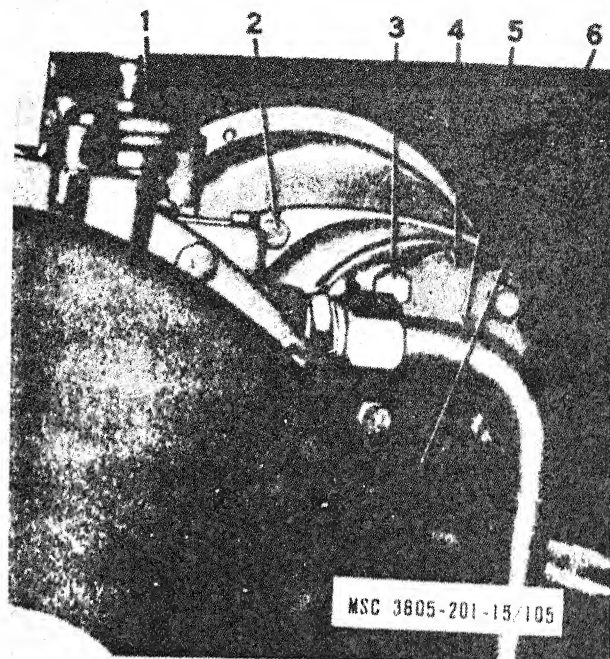
Figure 104. Torque converter oil filter, sectional view.

*c. Cleaning and Inspection.*

- (1) Clean all metallic parts with an approved solvent; dry thoroughly.
- (2) Inspect the filter for cracks, stripped threads, or other damage.
- (3) Inspect the hoses for cracks, deterioration, or other damage.
- (4) Replace the filter element, all gaskets, and unserviceable parts.

*d. Reassembly and Installation.*

- (1) Reassemble and install the torque converter and transmission oil filter by reversing the removal and disassembly procedure given in *b* above.
- (2) Check the transmission oil level as



- |                |                                     |
|----------------|-------------------------------------|
| 1 Transmission | 4 Charging pump                     |
| 2 Capscrew     | 5 Tube                              |
| 3 Capscrew     | 6 Transmission and torque converter |

Figure 105. Torque converter charging pump installation.

directed in paragraph 212. Fill if necessary.

## 214. Torque Converter Charging Pump

*a. Removal.*

- (1) Remove the right side panel from the loader. Disconnect the tube (5, fig. 105) from the transmission.
- (2) Remove the four capscrews (2) and lockwashers that secure the torque converter charging pump to the transmission pump drive housing; remove the pump gasket.

*b. Cleaning and Inspection.*

- (1) Wipe all dirt and grease from the exterior of the torque converter charging pump with a cloth dampened with an approved solvent; dry thoroughly.
- (2) Inspect the pump for cracks, signs of leakage, damaged splines, or defective operation; replace the pump if required.

*c. Installation.* Install the torque converter charging pump by reversing the removal procedure described in *a* above.

## Section XVI. DRIVE SHAFTS

### 215. General

a. The upper drive shaft transmits the power from the engine through the converter to the transmission. A universal spider and bearing assembly at each end of the shaft allows for lateral misalignment.

b. The lower drive shafts are identical. They transmit the power from the transmission to the axles at the front and rear of the loader. A universal spider and bearing assembly at each end of the shaft allows for lateral movement or misalignment, and the shaft is slip-jointed to allow for longitudinal movement.

### 216. Upper Drive Shaft (fig. 106)

#### a. Removal and Disassembly.

- (1) Park the loader on a level area; apply the parking brake.
- (2) Remove the left side panels from the loader.
- (3) Remove the four screws (9) and nuts (10) that secure the spider and bearing assembly (8) to the transmission input yoke.
- (4) Remove the four screws (9) and lockwashers (11) that secure the spider and bearing assembly to the engine companion flange (3); remove the assembled drive shaft and spider and bearing assemblies.
- (5) Remove the four screws (9) and nuts (10) that secure each of the two spider and bearing assemblies to the drive shaft (14); remove the spider and bearing assemblies.
- (6) If the nonmetallic washers (12) are damaged, remove the weld wires that secure the bearings to the spider; remove the bearings and the nonmetallic washers.
- (7) Remove the lubrication fitting (13) from each of the spiders.
- (8) Remove the 12 screws (7) and lockwashers (6) that secure the dust shield (5) to the flywheel housing; remove the dust shield.
- (9) Remove the companion flange (3) from the studs (1). If excessively worn or damaged, remove the eight

center bonded joints (4) from the companion flange.

- (10) Remove the lockwire (2) and the eight studs (1) from the engine flywheel if they are distorted or worn.

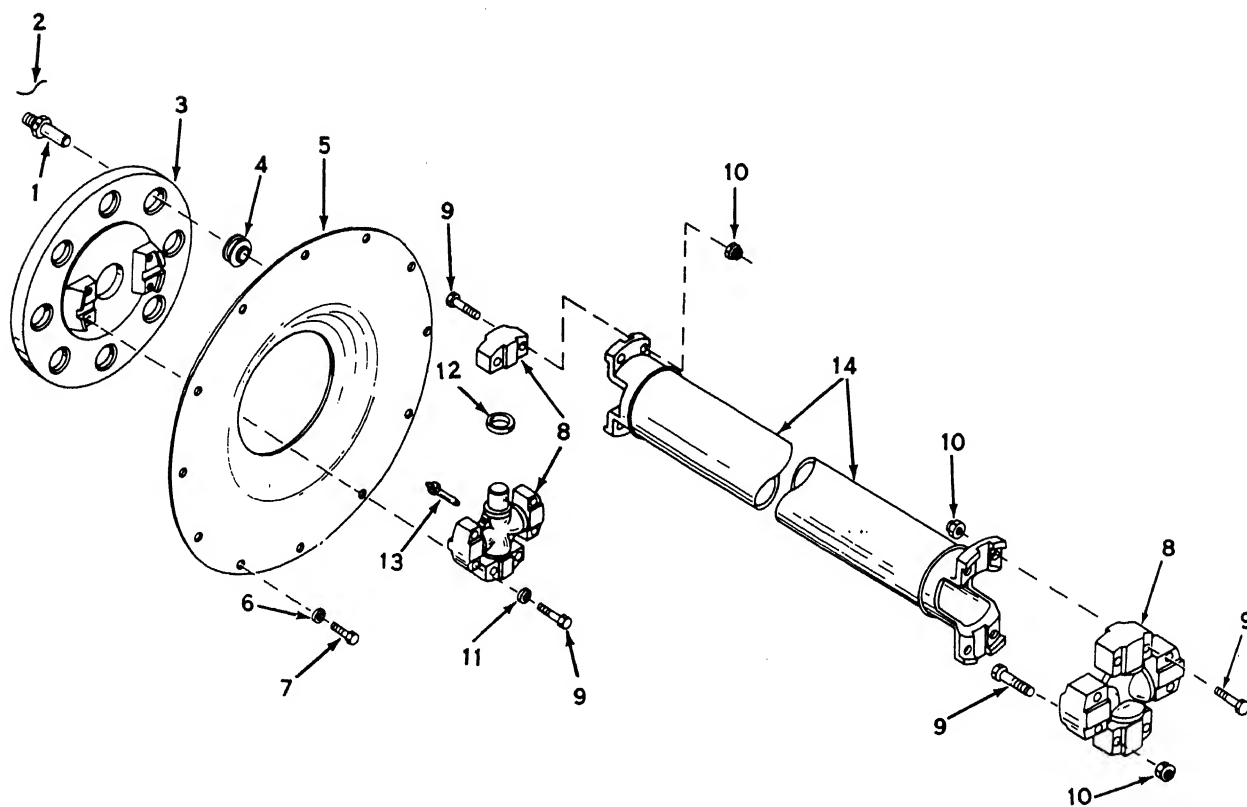
#### b. Cleaning and Inspection.

- (1) Clean all metal parts with an approved cleaning solvent; dry with compressed air. Take special care that none of the rollers are lost from the spider and bearing assemblies.
- (2) Inspect the spider and bearing assemblies for excessive wear, looseness, rough or binding operation, or other defects.
- (3) Inspect the drive shaft and companion flange for cracks, distortion, or other defects.
- (4) Replace the nonmetallic washers if dried out or damaged; replace all unserviceable parts.

#### c. Reassembly and Installation.

- (1) If the studs (1) were removed, install them on the engine flywheel; lock in pairs with the lockwires (2).
- (2) Replace any center bonded joints (4) that were removed from the companion flange on the studs.
- (3) Position the dust shield (5) on the flywheel housing; secure with the 12 screws (7) and lockwashers (6).
- (4) If the bearings were removed from the spider, position the four nonmetallic washers (12) and the bearings, with the faces of adjacent bearings turned 180° to each other, on the spider; hold the bearings tightly against the nonmetallic washers and tack-weld the weld wire that secures each pair of bearings to the spider.
- (5) Install a lubrication fitting (13) on each spider and bearing assembly (8).
- (6) Position the two spider and bearing assemblies on the drive shaft (14); secure each with the four screws (9) and nuts (10).
- (7) Position the assembled drive shaft and spider and bearing assemblies so that each spider and bearing assembly is aligned with the companion flange (3);





MSC 3805-201-15/108

- 1 Stud
- 2 Lockwire
- 3 Companion flange
- 4 Center bonded joint

- 5 Dust shield
- 6 Lockwasher
- 7 Screw

- 8 Spider and bearing assembly
- 9 Screw
- 10 Nut

- 11 Lockwasher
- 12 Nonmetallic washer
- 13 Lubrication fitting
- 14 Drive shaft

Figure 106. Upper drive shaft, exploded view.

secure with the four screws (9) and lockwashers (11).

- (8) Align the drive shaft spider and bearing assembly with the transmission input yoke; secure with the four screws (9) and nuts (10).
- (9) Lubricate the upper drive shaft as directed on the lubrication order (fig. 27).
- (10) Install the left side panels on the rear of the loader.

## 217. Lower Drive Shaft (fig. 107)

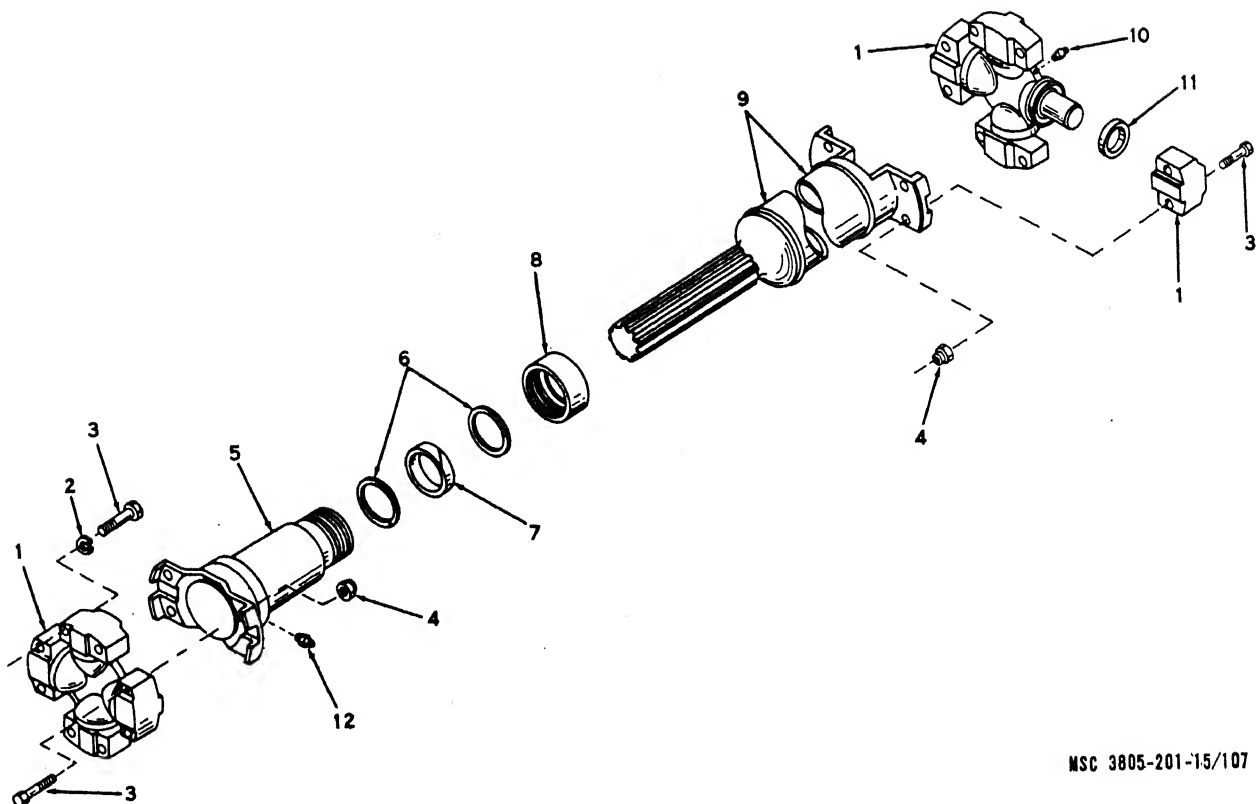
### a. Removal.

- (1) Block all wheels of the loader.
- (2) Remove the four screws (3) and nuts (4) that secure the bearing and spider assembly of the drive shaft to the yoke of the axle differential.
- (3) Remove the four screws (3) and lockwashers (2) that secure the bearing

and spider assembly to the transmission output flange; remove the drive shaft.

### b. Disassembly.

- (1) Remove the four screws (3) and nuts (4) that secure the spider and bearing assembly (1) to the tube (9), and the four screws and nuts that secure the spider and bearing assembly to the slip yoke (5); remove the spider and bearing assemblies.
- (2) If the nonmetallic washers (11) are damaged, remove the weld wires that secure the bearings to the spider; remove the bearings and nonmetallic washers.
- (3) Unscrew the felt retainer (8) from the slip yoke.
- (4) Slide the tube out of the slip yoke; remove the two retainer washers (6), nonmetallic washer (7), and retainer from the tube.



MSC 3805-201-15/107

- |                               |                   |                      |                        |
|-------------------------------|-------------------|----------------------|------------------------|
| 1 Spider and bearing assembly | 4 Nut             | 7 Nonmetallic washer | 10 Lubrication fitting |
| 2 Lockwasher                  | 5 Slip yoke       | 8 Felt retainer      | 11 Nonmetallic washer  |
| 3 Screw                       | 6 Retainer washer | 9 Tube               | 12 Lubrication fitting |

Figure 107. Lower drive shaft, exploded view.

- (5) Remove the lubrication fitting (10) from each spider and bearing assembly, and the lubrication fitting (12) from the slip yoke.

*c. Cleaning and Inspection.*

- (1) Clean all metal parts with an approved cleaning solvent; dry with compressed air. Take special care that none of the rollers are lost from the spider and bearing assemblies.
- (2) Inspect the spider and bearing assemblies for excessive wear, looseness,

rough or binding operation, or other defects.

- (3) Inspect the tube and slip yoke for cracks, distortion, stripped threads, damaged splines, or other defects.
- (4) Replace the nonmetallic washers if dried out or damaged; replace all unserviceable parts.

*d. Reassembly.*

- (1) Position the felt retainer (8), with the threaded side outward, the retainer washer (6), nonmetallic washer (7),

and second retainer washer on the tube (9).

- (2) Align the flange of the slip yoke (5) with the flange of the tube (9). Slide the tube into position on the slip yoke; tighten the felt retainer on the slip yoke threads.
- (3) If the bearings were removed from the spider, position the four nonmetallic washers (11) and bearings, with the faces of the adjacent bearings turned 180° to each other, on the spider; hold the bearings tightly against the non-metallic washers and tack-weld the weld wire to secure each pair of bearings to the spider.
- (4) Position a spider and bearing assembly (1) on the tube; secure with the four screws (3) and nuts (4).
- (5) Position the remaining spider and bearing assembly on the slip yoke; se-

cure with the four screws (3) and nuts (4).

- (6) Install the lubrication fitting (12) on the slip yoke; install the lubrication fitting (10) on each spider and bearing assembly.

*e. Installation.*

- (1) Position the lower drive shaft so the spider and bearing assembly on the slip yoke is aligned with the output flange of the transmission; secure with the four screws (3) and lockwashers (2).
- (2) Align the spider and bearing assembly on the tube end of the drive shaft with the yoke of the axle differential; secure with the four screws (3) and nuts (4).
- (3) Lubricate the lower drive shaft (fig. 27).
- (4) Remove the blocking from the loader wheels.

## Section XVII. BUCKET AND BOOM

### 218. General

*a.* The upper ends of the boom are secured to the loader frame with pinlocks which act as pivots for the boom arms. The piston rod ends of the boom cylinders attach to the middle of the boom arms with pinlocks which also act as pivots. As the piston rod of the boom cylinder is forced out of the cylinder, the boom is forced to raise.

*b.* The bucket is a two-segment type which may be used in four kinds of operation: bucket, clamshell, bulldozer, and scraper. The bucket operation is selected with the bucket lever of the control valve and is controlled by the two hydraulic bucket cylinders through levers and links mounted on the boom assembly. There are two hydraulic cylinders mounted on the bucket to operate the clam segment.

### 219. Bucket Assembly

*a. Removal.*

*Note.* If the cutting edge (1, fig. 108) of the bucket clam requires replacement, refer to a higher authority for maintenance

- (1) Disconnect the hydraulic tubes (33 and 37) from the swivel connectors (20, fig. 97) and plug the openings.

- (2) Remove the capscrew (27, fig. 109), lockwasher (26), flat washer (25), and pinlock (24) that secure each of the bucket links (22) to the bucket assembly; remove the preformed packing (23).
- (3) Remove the two capscrews (36), lockwashers (35), flat washers (34), pinlocks (33) and preformed packings (32) that secure the bucket assembly to the boom (1); remove the bucket assembly.

*b. Disassembly.*

- (1) Disconnect the two hoses (25, fig. 108) from the hydraulic cylinder assembly (24); plug the openings to prevent the entrance of dirt or other foreign matter.
- (2) Remove the cotter pin (6), clevis pin (7), and the upper clevis pin (5) that secure the piston rod of the clam cylinder to the bucket clam.
- (3) Support the bucket clam cylinder with a hoist or suitable blocking. Remove the cotter pin (38), clevis pin (39), and lower cylinder pin (40) that secure the clam cylinder assembly to

the bucket blade; remove the clam cylinder assembly.

- (4) Remove the four hoses (25) from the bucket.
- (5) Remove the hydraulic tubes (33 through 37) from the bucket.
- (6) Remove the cotter pins (54) that secure each of the two clam hinge pins (55). Remove the two clam hinge pins that secure the bucket clam (56) to the bucket blade (53); remove the bucket clam.
- (7) Remove the three plow bolts (52) and nuts (43) that secure each corner bit (50) to the bucket blade; remove the corner bits.
- (8) Remove the 13 plow bolts (52) and nuts (43) that secure the center cutting edge (51) to the bucket blade; remove the center cutting edge.
- (9) Remove the two capscrews (44 and 45) and nuts (47) that secure each of the nine teeth to the clam; remove the teeth. If the teeth are welded, refer to a higher authority for maintenance. Remove the pin (48) that secures the tooth tip (49) to each tooth shank (46); remove the tooth tips.
- (10) If excessively worn or damaged, remove the four bushings (4) from the clam. The bushings are tack-welded in place and will have to be chiseled loose.

*c. Cleaning and Inspection.*

- (1) Wipe all dirt and grease from the exterior of the clam cylinder assembly with a cloth dampened with an approved solvent; dry thoroughly.
- (2) Inspect the clam cylinder assembly for cracks, distortion, or defective operation; repair or replace as required.
- (3) Inspect the bushings and pins for excessive wear or distortion.
- (4) Inspect the hoses and fittings for cracks, deterioration, stripped threads, or other damage.
- (5) Thoroughly wash the parts of the bucket assembly with a hose and water.
- (6) Inspect the hydraulic tubes for cracks, dents, stripped threads, or other damage.
- (7) Inspect the pins for excessive wear or distortion.
- (8) Inspect the cutting edges for excessive

wear, damage, or distortion. If damaged, refer to a higher authority for maintenance.

- (9) Replace all unserviceable parts.

*d. Reassembly and Installation.* Reassemble and install the bucket by reversing the removal and disassembly procedure given in *a* and *b* above.

## **220. Bucket Position Indicator** (fig. 108).

*a. Removal.*

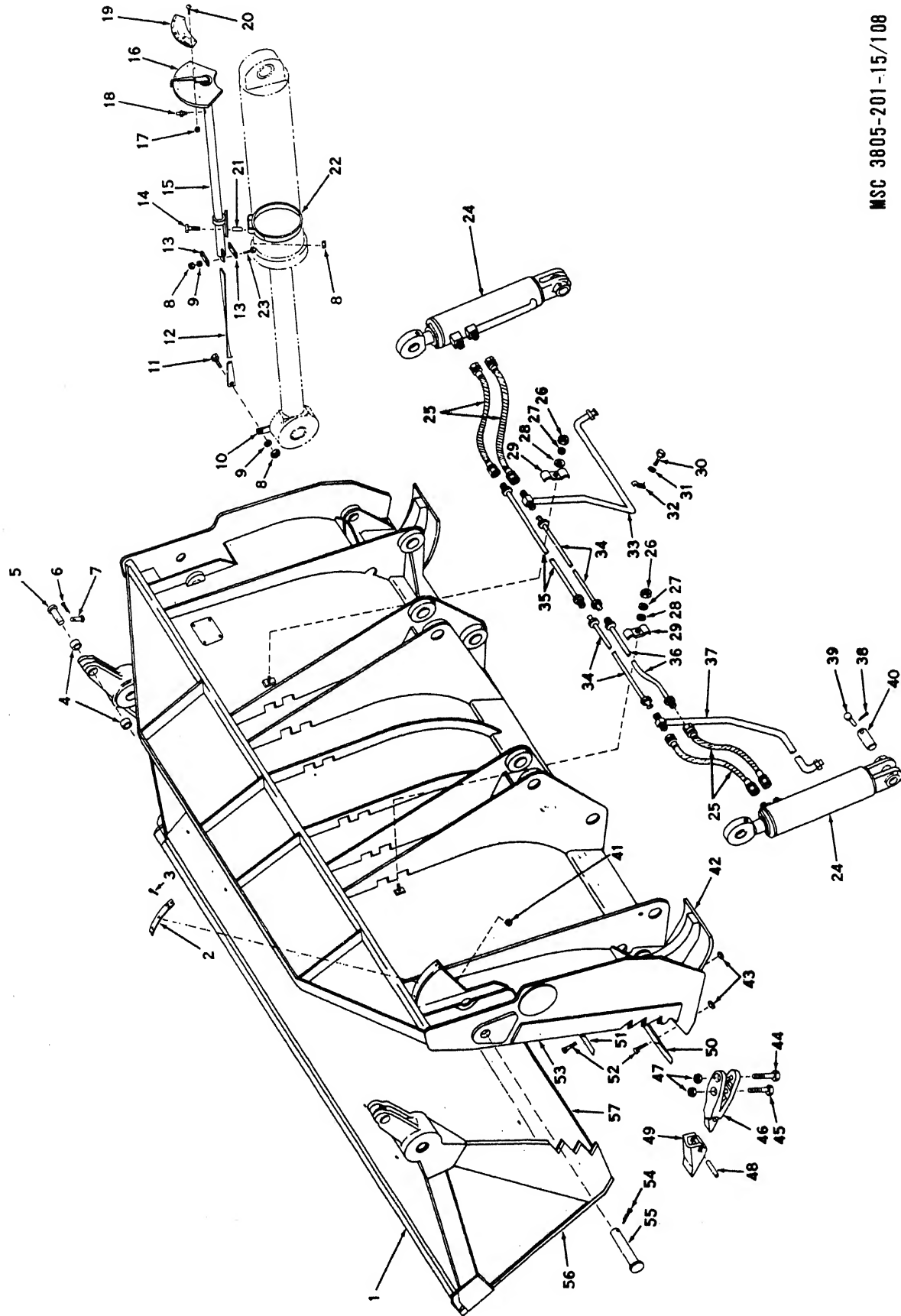
- (1) Remove the nut (8), lockwasher (9), and capscrew (11) from the rod holder (10); pull the indicator rod (12) from the needle and guide assembly (16).
- (2) Remove the nuts (8), lockwashers (9), and capscrews (23) from the guides (13); remove the guides. Remove the lubrication fitting (18).
- (3) Remove the nuts (17), screws (20), and indicator (19).
- (4) Remove the capscrews (14); nuts (8), and spacers (21) that secure the bearing bar (15) to the clamp (22).
- (5) Using a cutting torch, remove the rod holder (10) from the cylinder rod end and clean up the area with a file or portable grinder.
- (6) Extend the piston rod to the far out position to prevent overheating of the piston packing. Cut the needle and indicator assembly from the cylinder using a cutting torch. Clean up the area with a grinder or file.

*b. Cleaning and Inspection.*

- (1) Clean all parts with an approved cleaning solvent.
- (2) Inspect the indicator rod and guides for wear.
- (3) Check the needle and guide assembly for cracks, damage, or rough and catching rotation of the needle indicator.
- (4) Inspect the nuts and capscrews for damaged or worn threads. Inspect the indicator for illegible markings.
- (5) Replace defective parts.

*c. Installation.*

- (1) Connect the welder ground cable to the unpolished portion of the piston rod and tack-weld the rod holder (10) in place on the piston rod.



MSC 3805-201-15/108

Figure 108. Bucket, exploded view.

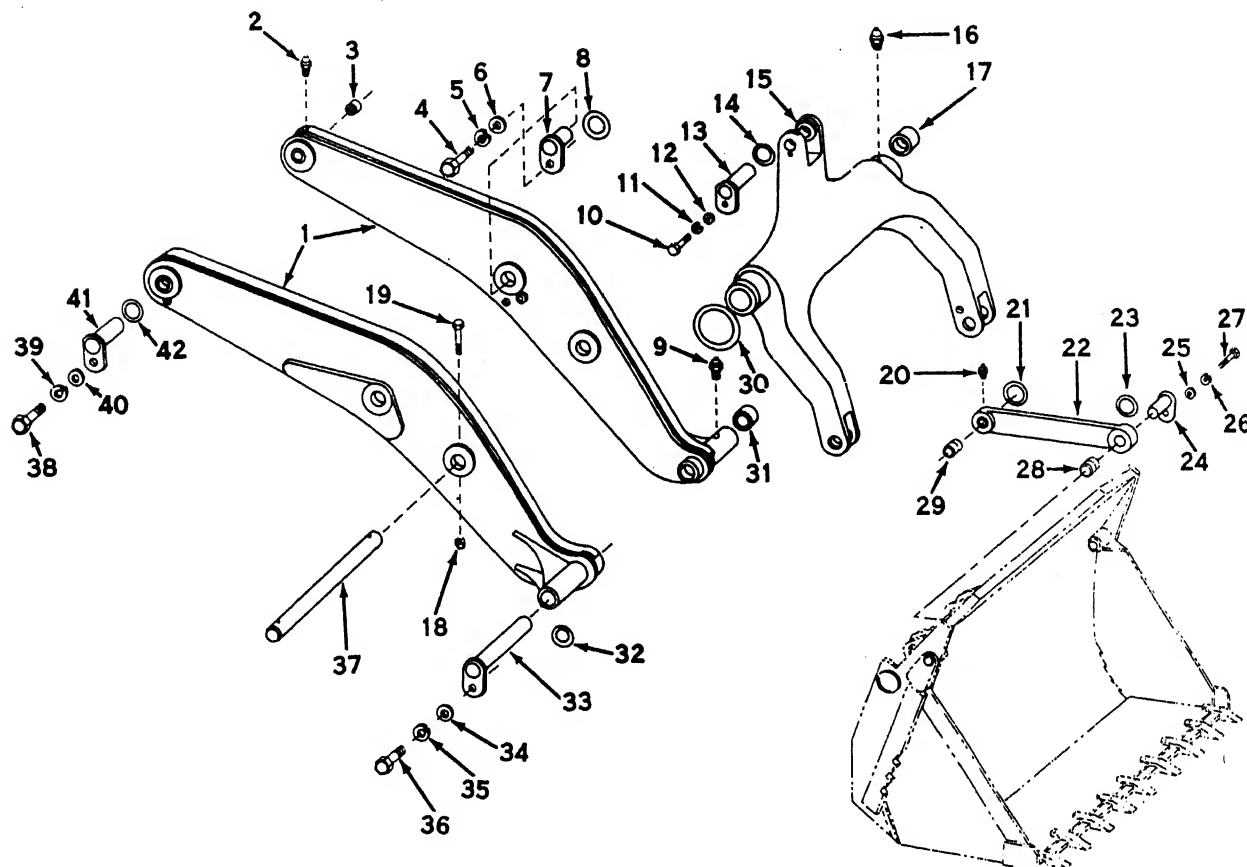
1 Cutting edge	16 Needle and guide assembly	30 Capscrew	44 Capscrew
2 Indicator	17 Nut	31 Lockwasher	45 Capscrew
3 Screw	18 Lubrication fitting	32 Clamp	46 Tooth shank
4 Bushing	19 Indicator	33 Hydraulic tube	47 Nut
5 Clevis pin	20 Screw	34 Hydraulic tube	48 Roll pin
6 Cotter pin	21 Spacer	35 Hydraulic tube	49 Tooth tip
7 Clevis pin	22 Clamp	36 Hydraulic tube	50 Corner bit
8 Nut	23 Capscrew	37 Hydraulic tube	51 Cutting edge
9 Lockwasher	24 Hydraulic cylinder	38 Cotter pin	52 Plow bolt
10 Rod holder	25 Hose	39 Clevis pin	53 Bucket blade
11 Capscrew	26 Nut	40 Pin	54 Cotter pin
12 Indicator rod	27 Lockwasher	41 Nut	55 Clevis pin
13 Guide	28 Washer	42 Shoe	56 Bucket clam
14 Capscrew	29 Clamp	43 Nut	57 Compaction plate
15 Bearing bar			

Figure 108—Continued.

- (2) Connect the welder ground cable to the cylinder and tack-weld the needle and guide assembly (16) in place. This must be done with the piston in the extended position to prevent damage to piston packings.
- (3) Position the indicator (19) and secure with the screws (20) and nuts (17). Install the lubrication fitting (18).
- (4) Install the spacers (21) between the bearing bar (15) and the clamp (22). Secure the bearing bar to the clamp with the capscrews (14) and the nuts (8). Install the guides (13) on the needle and guide assembly and secure with the capscrews (23), lockwashers (9), and nuts (8).
- (5) Insert the indicator rod (12) between the guides and into the needle and guide assembly; secure to the rod holder (10) with the capscrews (11), lockwashers (9), and nuts (8).
- (6) Actuate the hydraulic cylinder to determine that the needle reads correctly and that the mechanism works freely. If not, reposition the needle and guide assembly.
- (7) Connect the welding ground cable to the unpolished portion of the piston rod and complete the weld securing the rod holder to the piston rod. With the piston in the extended position, connect the welding ground cable to the hydraulic cylinder and complete the weld securing the guide and needle assembly to the cylinder.
- (8) Clean the welds and touch up damaged paint. Do not paint the indicator rod.
- (1) Remove the bucket as directed in paragraph 219a.
- (2) Block up securely under the bellcrank (15). Remove the capscrews (4), lockwashers (5), and flat washers (6) that secure the pinlocks (7) to the boom arms (1). Drive out the pinlocks and disengage the boom cylinders. Remove the preformed packing (8).
- (3) Wrap a sling around the bellcrank; support the bellcrank with a hoist.
- (4) Remove the capscrews (19) and nuts (18) that secure the bellcrank pivot shaft (37) to the boom arms (1). Drive the pivot shaft from the arms and the bellcrank.
- (5) Wrap a sling around the first boom arm to be removed; support the boom arm with a hoist.
- (6) Remove the capscrew (38), lockwasher (39), and flat washer (40) that secure the pinlock (41) to the boom arm. Remove the capscrew (19) and nut (18) that secure the pivot shaft (37) to the boom arm to be removed. Ease the one boom arm from the loader.
- (7) Remove the capscrew (10), lockwasher (11), and flat washer (12) that secure the pinlock (13) to the bellcrank. Drive out the pinlock and disengage the bucket cylinder from the bellcrank. Remove the preformed packing (14).
- (8) Wrap a sling around the remaining boom arm to be removed. Support the boom arm with a hoist. Remove the capscrew (38), lockwasher (39), and flat washer (40) that secure the pinlock (41) to the boom arm; drive out the pinlock and remove the preformed

## 221. Boom (fig. 109)

### a. Removal.



MSC 3805-201-15/109

1 Boom	12 Flat washer	23 Preformed packing	33 Pinlock
2 Lubrication fitting	13 Pinlock	24 Pinlock	34 Flat washer
3 Bushing	14 Preformed packing	25 Flat washer	35 Lockwasher
4 Capscrew	15 Bellcrank	26 Lockwasher	36 Capscrew
5 Lockwasher	16 Lubrication fitting	27 Capscrew	37 Pivot shaft
6 Flat washer	17 Bushing	28 Bushing	38 Capscrew
7 Pinlock	18 Nut	29 Bushing	39 Lockwasher
8 Preformed packing	19 Capscrew	30 Preformed packing	40 Flat washer
9 Lubrication fitting	20 Lubrication fitting	31 Bushing	41 Pinlock
10 Capscrew	21 Preformed packing	32 Preformed packing	42 Preformed packing
11 Lockwasher	22 Bucket link		

Figure 109. Boom and bucket, exploded view.

packing (42). Carefully remove the boom arm.

*b. Cleaning and Inspection.*

- (1) Discard all preformed packings. Clean the boom and bellcrank with water under pressure. Remove any greasy or gummy deposits with a cloth dampened with an approved cleaning solvent. Wash all remaining metallic parts with solvent.
- (2) Inspect the boom arms and bellcrank for cracks, broken weldments, distortion, and other damage. Inspect the bushings (3 and 31) in the boom arms

and the bushing (17) in the bellcrank for wear, scoring, or other damage. If the bushings are damaged, drive them from the boom arms or bellcrank and drive in new bushings.

- (3) Inspect the pinlocks and the pivot shaft for wear of the working surfaces; replace if worn or badly scored.
- (4) Inspect all other parts for cracks, distortion, and damaged threads; replace damaged parts.

*c. Installation.* Install the boom by reversing the removal procedure described in *a* above.



# CHAPTER 4

## FIELD AND DEPOT MAINTENANCE INSTRUCTIONS

### Section I. GENERAL

#### 222. Scope

a. These instructions are published for the use of field and depot maintenance personnel maintaining the Frank G. Hough Model H-90CM Scoop Type Loader. They provide information on the maintenance of the equipment, which is beyond the scope of the tools, equipment, personnel, or supplies normally available to using organizations.

b. Appendix I includes the publications ap-

plicable to field and depot maintenance. Appendix II contains the maintenance allocation chart. The field and depot maintenance repair parts and special tool lists are listed in TM 5-3805-201-35P.

#### 223. Overhaul and Replacement Standards

The overhaul and replacement standards for this equipment are shown in table 1.

Table 1. Overhaul and Replacement Standards

Component	Desired clearance		Allowable wear and clearance	Manufacturer's dimensions and tolerances in inches	
	Min (in.)	Max (in.)		Min	Max
ENGINE GROUP					
Camshaft:					
Bearing journal OD.....			1.871 min	1.872	1.873
End play.....	0.007	0.011	0.015 max		
Camshaft bushings ID.....			1.878 max	1.8745	1.8765
Cylinder liner ID.....			4.130 max	4.125	4.126
Upper flange diameter to engine block counterbore.....	0.0005	0.0045		4.874	4.876
	inter-	inter-			
	ference	ference			
Projection of sleeve flange above engine block deck (variation between liners should be less than 0.001 in.).	0.0015	0.0057			
Crankshaft:					
Connecting rod journal OD.....			2.622 min	2.624	2.625
Main bearing journal OD.....			3.872 min	3.874	3.875
Connecting rod to crankshaft.....	0.006	0.009	0.008		
End play.....	0.002	0.045	0.008 max		
Crankshaft main bearing shells (thickness).....			0.1216 min	0.1231	0.1236
Connecting rod pin bushings ID.....			1.5015 max	1.5000	1.5005
Connecting rod:					
Crankpin bore (connecting rod caps installed at operating torque).....				2.7725	2.7730
Out-of-round.....			0.002 max		
Connecting rod alinement (rod caps turned 180° and replaced).....			0.004 max		
Connecting rod bearing shells (thickness).....			0.071 min	0.07225	0.07275
Piston pin OD.....			1.4978 min	1.4988	1.4990
Piston:					
Pin bore ID.....			1.500 max	1.4988	1.4990
Skirt OD (at 70° F.).....			4.1185 min	4.118	4.119
Top and second ring grooves (measured against new ring, 0.006 feeler gage should not enter groove).....			0.005 max		
Ring gap (ring and piston assembled, installed in cylinder).....	0.013	0.023			
Rocker lever bushings ID.....			1.1265 max	1.1245	1.1265
Rocker lever adjusting screw ball ends.....			Radius check, reject for flat spots		

Table 1. Overhaul and Replacement Standards—Continued

Component	Desired clearance		Allowable wear and clearance	Manufacturer's dimensions and tolerances in inches	
	Min (in.)	Max (in.)		Min	Max
Injector rocker lever ball sockets .....			Radius check, use good push rod and prussian blue, reject for flat spots		
Rocker lever shaft OD .....			1.122 min	1.123	0.1235
Valve tappet roller ID .....			0.505 max	0.503	0.504
Valve tappet roller OD .....			1.059 min	1.061	1.063
Valve tappet roller pin OD .....			0.4985 min	0.4995	0.5000
Injector tappet rollers ID .....			0.5675 max	0.5655	0.5665
Injector tappet rollers OD .....			1.121 min	1.123	1.125
Injector tappet roller pin OD .....			0.561 min	0.562	0.5625
Valve tappets OD .....			1.184 min	1.185	1.186
Injector tappets OD .....			1.309 min	1.310	1.311
Injector sleeve ID (new, expanded for injector body) .....				1.375	1.380
Valve guides ID .....			0.345 max	0.3425	0.3432
(Valve guide height above cylinder head surface) .....	1.240	1.260			
Valve seat (width) .....				0.0625	0.125
Crosshead:					
Guide bore .....			0.378 max	0.3755	0.376
Stem OD .....			0.3700 min	0.3708	0.3713
Valve:					
Head rim (thickness) .....			0.0625 min	0.081	0.091
Stem OD .....			0.339 min	0.340	0.341
Cylinder head (thickness) .....			4.970		
Injector cup tips (protrusion above cylinder head surface) .....	0.040	0.055	0.065		
Engine block:					
Linear counterbore ledge depth (variation of more than 0.001 in. between inner edge and outer edge requires reconditioning) .....			0.31050	0.30925	0.31050
Crankshaft bore runout .....			Check with SF409. If bar goes through, alinement is good.		
Main bearing cap alinement ID (bearing caps installed at operating torque) .....	4.124	4.125			
Flywheel bore runout .....			0.004 max		
Flywheel face runout .....			0.005 max		

#### FUEL PUMP

Front drive shaft bushing .....			0.7525 max	0.7495	0.7505
Gear pump gears:					
Gear thickness .....			0.7481	0.7483	0.7486
Gear protrusion above gasket surface .....			0.0007 max		
Gear shaft end play .....			0.002 max		
Governor plunger to thrust washer clearance .....	0.002	0.005			
Governor assist plunger protrusion above cover gasket face .....	0.860	0.880			

#### AIR COMPRESSOR

Exhaust valve seat (thickness, measured from shoulder to top of seat) .....			0.485 min	0.495	0.500
Intake valve seat (thickness, measured from shoulder to top of seat) .....			0.270 min	0.275	0.280
Crankcase:					
Cylinder bore ID .....			3.443 max	3.4395	3.4405
Cylinder bore out-of-round .....			0.0015 max		

Table 1. Overhaul and Replacement Standards—Continued

Component	Desired clearance		Allowable wear and clearance	Manufacturer's dimensions and tolerances in inches	
	Min (in.)	Max (in.)		Min	Max
Piston OD (measured 1 in. below and at right angles to pin bore).....			3.433 min	3.4355	3.4365
Piston ring gap (piston and rings assembled, installed in cylinder bore).....	0.010	0.026			
Connecting rod:					
Piston pin bushing ID.....			0.6895 max	0.6880	0.6885
Crankshaft bushing ID.....			1.3787 max	1.3762	1.3772
Side clearance.....	0.003	0.008			
Crankshaft:					
Out-of-round.....			0.001 max		
End play.....	0.004	0.009			
Support bushings ID.....			1.7555 max	1.7525	1.7535

#### TORQUE CONVERTER CHARGING PUMP

Spur, gearshaft to bushing clearance.....			0.005 max	0.0015	0.0035
Clearance between rollers of roller bearings.....			0.020		
Housing gear bores (measured through dowel pin centerline).....			3.259 max		

#### DIFFERENTIAL

Drive gear:	Rockwell		0.008 max		
Gear runout.....					
Gear backlash.....	0.006	0.012			
Gear to thrust block clearance.....	0.010	0.015			

#### TRANSMISSION

Forward and reverse clutch:					
Friction disk.....			0.089	0.099	0.104
Steel disk.....			0.057	0.067	0.071
Thrust washer.....			0.081	0.091	0.095
Thrust washer.....			0.0101	0.111	0.128
Range clutch:					
Friction disk.....			0.049	0.059	0.064
Steel disk.....			0.035	0.045	0.049
Thrust washer.....			0.101	0.111	0.128
Splitter clutch:					
Friction disk.....			0.049	0.059	0.064
Steel disk.....			0.057	0.067	0.071
Thrust washer.....			0.081	0.091	0.095
Output shaft thrust washer.....			0.107	0.117	0.121

## Section II. ENGINE OVERHAUL

### 224. Preparing the Engine for Removal From the Loader

a. Lower the bucket to the ground and block all four wheels of the loader.

b. Drain the cooling system as directed in paragraph 148b.

c. Drain the engine lubrication system as directed in paragraph 154b.

d. Disconnect the engine lubricating oil drain hoses and the engine lube oil filter hoses; drain the oil cooler.

e. Close the shutoff cock on the fuel tank. Disconnect the fuel pump-to-tank hose (6, fig. 31) and the filter-to-pump hose (3) at the fuel pump. Remove the injector return hose (7).

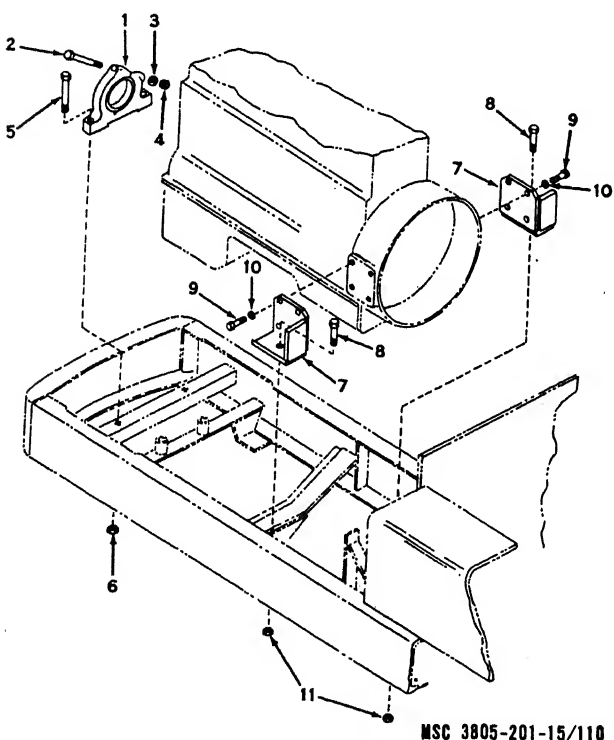
f. Remove the drain plug from the bottom of the fuel pump; use a clean container to catch the fuel that drains. Replace the fuel pump drain plug.

## 225. Removing the Engine and Accessories From the Loader

*Note.* Tag all leads, hoses, and fittings to facilitate reassembly.

a. Remove the grille, as directed in paragraph 178a, and the rear hood, as directed in paragraph 182a.

b. Remove the converter oil cooler and radiator as directed in paragraph 151a. Remove the turbocharger as directed in paragraph 163c.



- |              |               |
|--------------|---------------|
| 1 Trunnion   | 7 Bracket     |
| 2 Bolt       | 8 Bolt        |
| 3 Lockwasher | 9 Bolt        |
| 4 Nut        | 10 Lockwasher |
| 5 Bolt       | 11 Nut        |
| 6 Nut        |               |

Figure 110. Engine mounting part, exploded view.

c. Remove the hex nut and lockwasher that secure the ball joint of the accelerator rod (15, fig. 35) to the throttle lever (16) on the fuel pump.

d. Disconnect the line (7) of the primer discharger from the nozzle on the intake manifold.

e. Disconnect the electrical leads to the fuel shutoff valve (20), the engine oil pressure sender, and the engine oil pressure switch. Disconnect the electrical leads to the generator, the starting motor, and the fuel shutoff valve on the fuel pump.

**Warning:** Disconnect all battery cables at the batteries before disconnecting any electrical leads to the engine.

f. Disconnect the filter-to-engine and engine-to-filter hoses at the engine oil pressure relief valve as directed in paragraph 157a.

g. Remove the compressor-to-air governor tube (1), the compressor outlet hose (22), and the air intake tube (9).

h. Disconnect the voltage regulator-to-ammeter lead from the voltage regulator.

i. Remove the upper rear drive shaft as directed in paragraph 216a.

j. Use a lifting fixture to provide a means of hoisting the engine. Insert the hook of the hoist into the hole at the top of the fixture and take up slack in the hoist.

k. Remove the two nuts (6, fig. 110) and bolts (5) that secure the trunnion (1) at the front of the engine to the loader frame. Remove the eight bolts (9) and lockwashers (10) that secure the engine flywheel housing to the engine supports.

l. Carefully lift the engine and accessory drive from the loader, moving it toward the rear of the loader as the engine clears the frame. Mount the engine on a suitable stand.

## 226. Removal of Accessories From the Engine

a. Remove the generator as directed in paragraph 139d.

b. Remove the turbocharger as directed in paragraph 163c.

c. Remove the starting motor as directed in paragraph 141b.

d. Remove the voltage regulator as directed in paragraph 140a.

e. Remove the fuel pump as directed in paragraph 130c.

f. Remove the air compressor as directed in paragraph 195a.

g. Remove the fan and bracket as directed in paragraph 152a.

h. Remove the thermostat housing as directed in paragraph 149a.

i. Remove the water pump as directed in paragraph 150a.

j. Remove the engine oil cooler as directed in paragraph 156a.

k. Remove the lubricating oil pressure relief valve as directed in paragraph 157a.

## 227. Engine Disassembly Into Major Subassemblies

a. Remove the engine from the loader as directed in paragraph 223. Remove the engine accessories as directed in paragraph 224.

b. Remove the exhaust manifolds as directed in paragraph 166a; remove the intake manifold as directed in paragraph 167a.

c. Remove the cylinder head cover from the engine as directed in paragraph 164a.

d. Remove the fuel supply and drain manifolds as directed in paragraph 132a.

e. Remove the injector fuel connections as directed in paragraph 133b.

f. Remove the seven long screws (27, fig. 111) and plain washers (29) that secure the cylinder head and rocker shaft bearings to the cylinder block.

g. Remove the seven screws (4, fig. 129) that secure the rocker shaft bearings (3 and 5-7) to the cylinder head.

h. Carefully pry the rocker lever assembly from the dowel pins. Use a bar or a wooden slat to keep the levers in position as shown in figure 112; lift and remove the rocker lever assembly and crossheads.

i. Remove the two screws that secure each injector in the cylinder head; lift the injector from the cylinder head, being careful not to damage the injector cup tip. Place the injectors in a rack that is numbered to correspond to the cylinder numbers from which they are removed.

j. Lift the injector push rod (8, fig. 113) and the intake and exhaust push rods (7) for each cylinder from their sockets; remove the push rods.

k. Remove the seven short screws (28, fig. 111) and plain washers (29) that secure the cylinder head to the cylinder block (11); lift the cylinder head assembly from the engine block.

*Note.* Do not allow the cylinder head machined surface to contact any object that may nick or scratch it. A nick or scratch may cause a blown head gasket during engine operation.

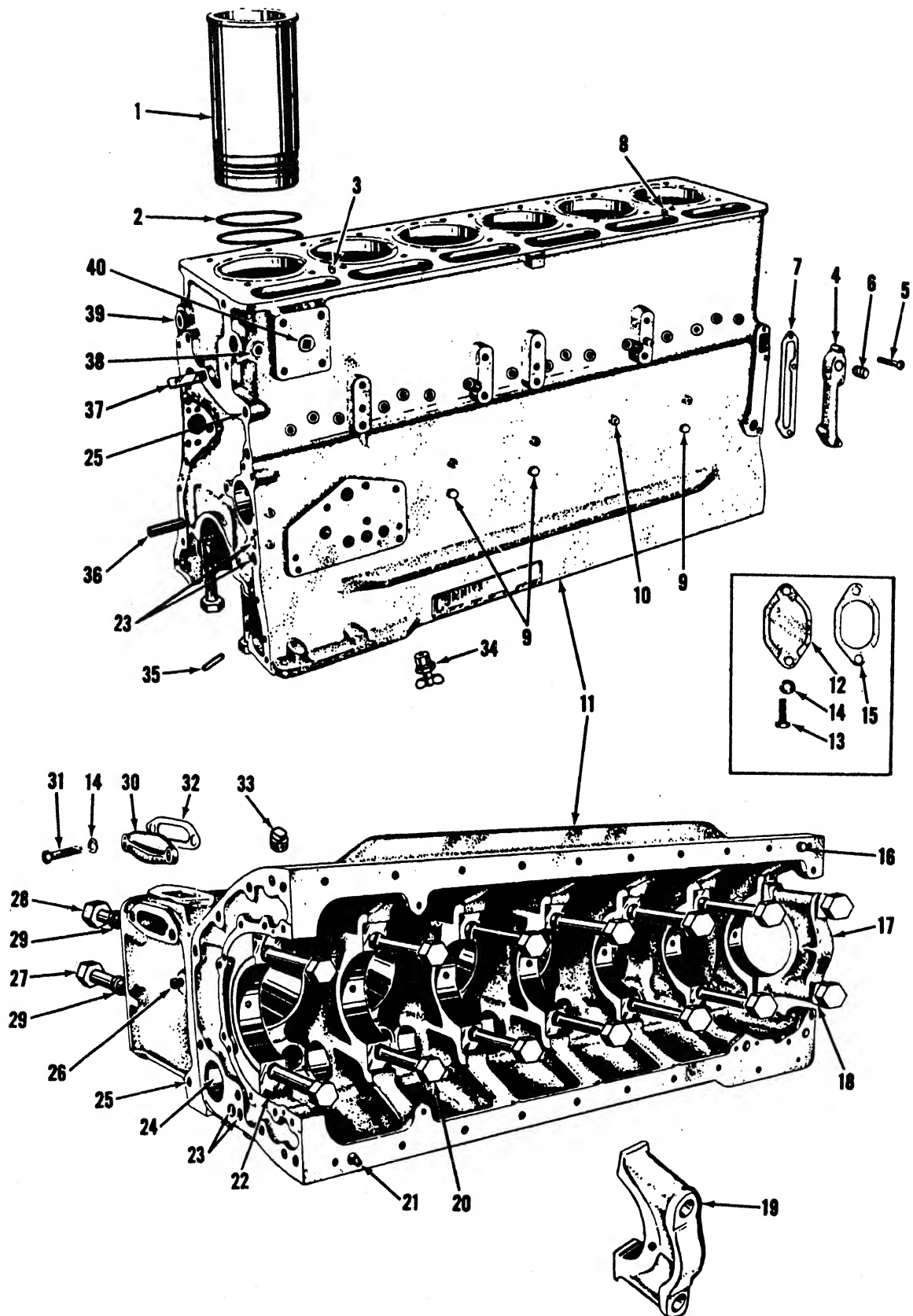
l. Remove the cylinder head gasket (20, fig. 134), grommet retainer (25), grommets (21, 22, and 24), and the rings (23) from the cylinder block.

m. Remove the tappet guides (1, fig. 113) from the side of the cylinder block. Remove the assembled intake and exhaust valve tappets and the assembled injector tappets.

n. Remove the lockwire (15, fig. 114) from the six screws (14) that secure the flywheel (1) to the crankshaft; remove the screws. Screw two  $\frac{1}{2}$ -20 by 4- or 5-inch long studs into the crankshaft flange through the two holes in the flywheel, as shown in figure 115, for the flywheel to ride on when pulled from its mountings. Insert two  $\frac{1}{2}$ -13 by  $2\frac{1}{2}$ -inch long fully threaded screws into two threaded holes of the flywheel; tighten finger tight. Tighten the two screws equally against the crankshaft flange to pull the flywheel from its mounting; remove the flywheel and the studs and screws used for pulling it. If the two dowel pins (16, fig. 114) are loose or damaged, remove them from the crankshaft.

o. Remove the four screws (11), lockwashers (12), and plain washers (13) that secure the flywheel housing (5) to the oil pan, and the eight screws (3) and lockwashers (4) that secure the flywheel housing to the cylinder block. Drive the flywheel housing from its mounting dowel pins (6) with light blows from a block of wood or a soft hammer; remove the flywheel housing and gasket (7). Remove the two screws (8) and lockwashers (9) that secure the index hole cover (10); remove the index hole cover.

p. Turn the engine upside down, supporting it so that the cylinder head surface will not be scratched and there will be sufficient clearance for removal of the pistons. Remove the 26 screws (1, 5, 6, 30, and 31, fig. 116), lockwashers (2), and the plain washers (3) that secure the oil pan (18) to the cylinder block; remove the oil pan and gasket (4).



MSC 3805-201-15/111

Figure 111. Cylinder block, disassembled view.

- |                                    |                                   |                                |                                     |
|------------------------------------|-----------------------------------|--------------------------------|-------------------------------------|
| 1 Cylinder liner                   | 11 Cylinder block                 | 21 Oil pan-to-block dowel pin  | 31 Water header end cover screw     |
| 2 Cylinder liner packing rings     | 12 Water header side cover        | 22 Main bearing cap dowel pin  | 32 Water header end cover gasket    |
| 3 Cylinder head-to-block dowel pin | 13 Water header side cover screw  | 23 Allen head plug             | 33 Water header plug                |
| 4 Oil transfer connection          | 14 Water header cover lockwasher  | 24 Camshaft bushing            | 34 Drain cock                       |
| 5 Oil transfer connection screw    | 15 Water header side cover gasket | 25 Oil gallery-to-tappet plug  | 35 Lubricating pump block dowel pin |
| 6 Oil transfer plug                | 16 Oil pan-to-block dowel pin     | 26 Rear water drain plug       | 36 Gear case cover dowel pin        |
| 7 Oil transfer connection gasket   | 17 Main bearing cap               | 27 Cylinder head screw (long)  | 37 Gear case cover dowel pin        |
| 8 Cylinder head-to-block dowel pin | 18 Main bearing screw lockplate   | 28 Cylinder head screw (short) | 38 Water drain plug                 |
| 9 Hex head plug                    | 19 Main bearing cap               | 29 Cylinder head plain washer  | 39 Plug                             |
| 10 Oil gallery plug                | 20 Main bearing screw             | 30 Water header and cover      | 40 Socket head plug                 |

Figure 111—Continued.

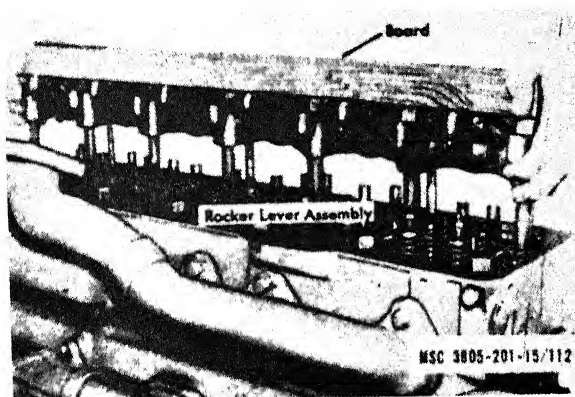
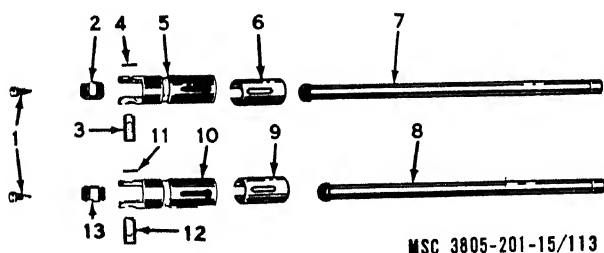


Figure 112. Removing rocker lever assembly.



- |                                   |                                 |
|-----------------------------------|---------------------------------|
| 1 Tappet guide                    | 8 Injector push rod             |
| 2 Valve tappet roller             | 9 Injector tappet guide sleeve  |
| 3 Valve tappet roller pin         | 10 Injector tappet              |
| 4 Valve tappet pinlock            | 11 Injector tappet pin lockwire |
| 5 Intake and exhaust valve tappet | 12 Injector tappet roller pin   |
| 6 Valve tappet guide sleeve       | 13 Injector tappet roller       |
| 7 Valve push rod                  |                                 |

Figure 113. Tappets and push rods, disassembled view.

q. Remove the two screws (29) and lockplates (21) that secure the oil drain tube (28) to the cylinder block; remove the oil drain tube.

r. Remove the two screws (8) and lockwashers (9) that secure the suction tube brackets

(7). Remove the two nuts (12) and washers (11) that secure the brackets to the suction tube assembly (10); remove the brackets.

s. Remove the three screws (33 and 34, fig. 133) and lockplates (35) that secure the lubricating oil pump to the cylinder block; remove the lubricating oil pump. If the two dowel pins (39) are loose or damaged, remove them from the cylinder block.

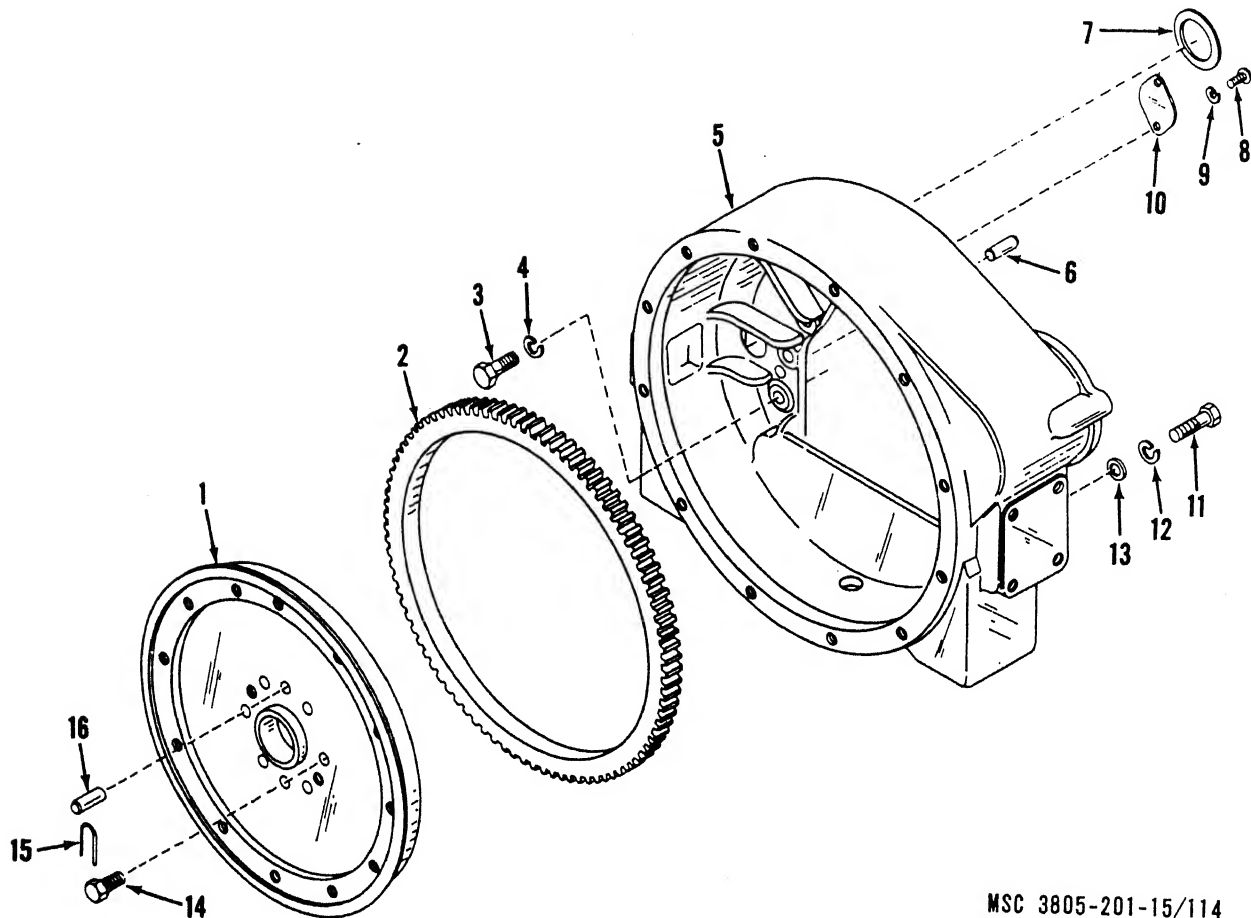
t. Remove the six screws (3, fig. 117) and the three lockplates (2) that secure the vibration damper (1) to the vibration damper hub (11, fig. 118). Remove the retainer screw (13), lockwasher (14), and the retainer (12) from the crankshaft (5). Install a pulling tool; pull the vibration damper hub and remove the key from the crankshaft. Remove the vibration damper from hub.

u. Loosen the bolt of the engine support trunnion; slide the engine support trunnion off the gear cover.

v. Remove the screws (3, 8, 9, 11, and 16, fig. 119) and lockwashers (12) that secure the gear cover (2) to the cylinder block and the gear housing plate; carefully pry the gear cover from the mounting dowel pins (19 and 20). Remove the gear cover and the gasket (1). Press the oil seals (7 and 10) out of the cover. Remove the plugs (6, 13, and 14) from the gear cover.

w. Remove the three screws (2, fig. 120) and lockwashers (3) that secure the camshaft front bearing (4) to the cylinder block. (These screws are reached through the openings of the camshaft gear.) Rotate the camshaft gear (1) slightly to disengage the gear teeth while pulling the camshaft (5) from the cylinder block.





MSC 3805-201-15/114

- 1 Flywheel
- 2 Ring gear
- 3 Screw
- 4 Lockwasher

- 5 Flywheel housing
- 6 Dowel pin
- 7 Gasket
- 8 Screw

- 9 Lockwasher
- 10 Index hole cover
- 11 Screw
- 12 Lockwasher

- 13 Washer
- 14 Screw
- 15 Lockwire
- 16 Dowel pin

Figure 114. Flywheel housing, exploded view.

x. Remove the screws (17 and 16, fig. 119) that secure the gear housing plate (15) to the cylinder block; remove the housing plate and gasket (18).

Note. Three socket head screws are peened into place. A special  $\frac{1}{4}$ -inch socket head wrench with extension must be used to remove these screws.

y. Remove the eight screws (4 and 5, fig. 121) and lockwashers (6) that secure the cylinder block rear cover (1); remove the rear cover and gasket (2). Remove the oil seal (3) from the rear cover.

z. Scrape all the carbon from the top of the cylinder liner bore of each cylinder.

aa. Remove the four nuts (6, fig. 128), two lockplates (7), and two U-bolts (9) that secure each of the connecting rod bearing caps; remove the bearing caps and bearing halves (8)

one by one. Tape the bearing halves together and identify them by the cylinder number as they are removed.

ab. Push the connecting rod and the piston assembly from the cylinder liner with a wooden stick, taking care that the piston is not dropped or damaged. Reassemble the connecting rod U-bolts, bearing caps, and nuts as they are removed; identify each piston assembly by its cylinder number.

ac. Loosen each of the screws (20, fig. 111) that secure the seven main bearing caps (17 and 19) until approximately five threads remain engaged in the cylinder block (11). Pry each of the main bearing caps loose. Remove the two screws (20) and the lockplates (18) that secure each bearing cap; remove and number each bearing cap and the lower main bear-

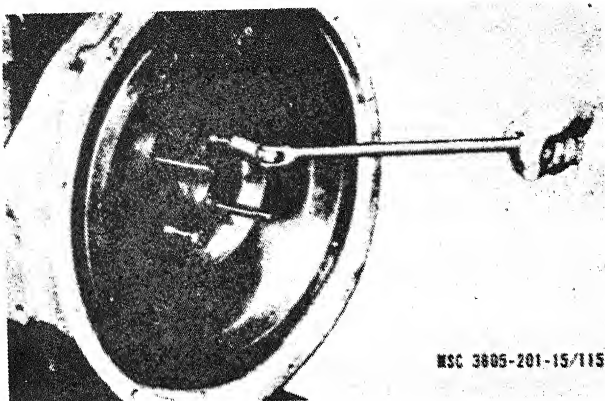


Figure 115. Removing flywheel.

ing half (4, fig. 118). Remove the two thrust rings (3) and the four dowel pins (2) from the No. 7 main bearing cap (19, fig. 111).

*ad.* Use rope or rubber-covered hooks to lift the crankshaft (5, fig. 118) from the cylinder block. Remove the upper bearing halves (1) and tape them to the correspondingly numbered lower bearing halves (4). Remove the two remaining thrust rings (3).

## 228. Cleaning and Inspection of Major Subassemblies

*a.* Clean all dirt, carbon, and particles of old gaskets from the intake and exhaust manifolds. Inspect the manifolds for cracks, breaks, or warpage.

*b.* Clean the fuel inlet manifold and the fuel drain manifold with cleaning solvent to remove any sludge or gum deposits. Inspect the fuel inlet and drain manifolds for cracks, kinks, or other damage.

*c.* Clean all dirt and grease from the flywheel and housing with cleaning solvent. Inspect the flywheel and the flywheel housing for cracks, damaged threads, or other defects.

*d.* Clean the camshaft with cleaning solvent, dry with compressed air, and coat lightly with clean oil. Inspect the camshaft; replace if the injector or valve lobes are scuffed, scored, or cracked, or if the bearing journals are worn to less than 1.871-inch outside diameter. If it is necessary to replace the camshaft gear (1, fig. 120), heat the camshaft (5); remove the camshaft gear with a gear puller. Remove the key (6) and the front bearing (4) from the camshaft. To replace the gear, install the cam-

shaft front bearing (4); position the key on the camshaft. Heat the camshaft gear (1); align the key slot with the camshaft key. Drive the camshaft gear into position.

*e.* Clean the gear case cover and the gear housing plate by brushing with cleaning solvent; scrape off any particles of old gaskets. Inspect the cover for cracks, scratched or rough oil seal bores, damaged threads, or other defects.

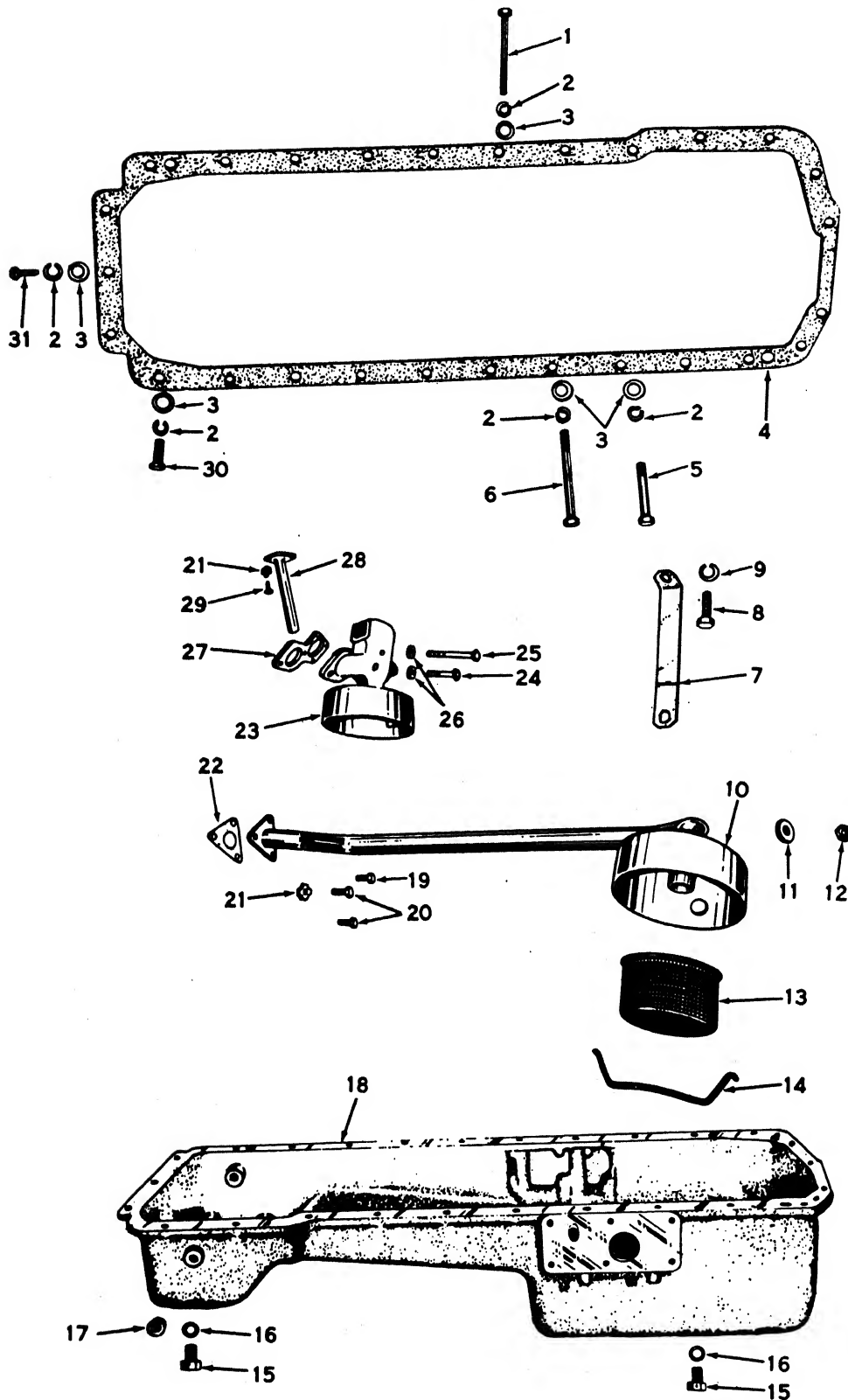
*f.* Clean the cylinder block rear cover with cleaning solvent. Inspect the rear cover for cracks, scratched or rough oil seal bore, or other defects.

*g.* Replace all gaskets, oil seals, lockplates, and all worn, damaged, or defective parts.

## 229. Engine Cylinder Block

### *a. Disassembly.*

- (1) Remove the cylinder block as directed in paragraphs 227*a* through *k*.
- (2) Position the cylinder block so that it is right side up. Use a puller as shown in figure 122 to pull the cylinder liners (1, fig. 111) from the bores in the cylinder block (11). The puller bottom plate pivots on the central screw and engages the bottom surface of the cylinder liner. The top plate of the puller straddles the cylinder liner. Turn the hex nut on the central screw to remove each liner. Remove the two packing rings (2) from the cylinder liner.
- (3) Remove the four screws (5) that secure the oil transfer connection (4) to the cylinder block; remove the oil transfer connection and the gasket (7). Remove the plug (6) from the connection.
- (4) Remove the two screws (31) and lockwashers (14) that secure the water header end cover (30) to the cylinder block; remove the water header end cover and gasket (32).
- (5) Remove the two screws (13) and lockwashers (14) that secure the water header side cover (12) to the cylinder block; remove the water header side cover and gasket (15).



MSC 3805-201-15/118

Figure 116. Oil pan and suction tube assemblies, exploded view.

1 Screw	9 Lockwasher	16 Drain plug gasket	24 Screw
2 Lockwasher	10 Suction tube assembly	17 Plug	25 Screw
3 Washer	11 Washer	18 Oil pan	26 Washer
4 Oil pan gasket	12 Nut	19 Screw	27 Suction tube gasket
5 Screw	13 Suction screen	20 Screw	28 Oil drain tube
6 Screw	14 Suction screen support	21 Lockplate	29 Screw
7 Suction tube bracket	15 Drain plug	22 Suction flange gasket	30 Screw
8 Screw		23 Suction tube	31 Screw

Figure 116—Continued.

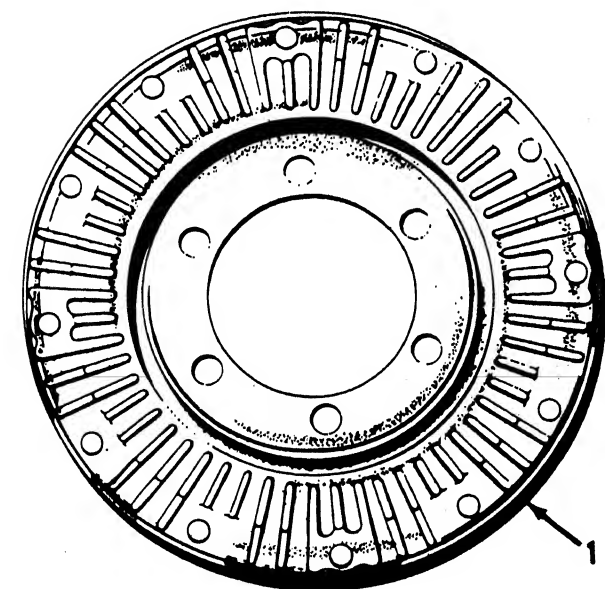
- (6) Remove the drain cock (34) from the cylinder block.
- (7) If the cylinder head-to-block dowel pins (3 and 8), main bearing cap dowel pins (22), oil pan-to-block dowel pins (16 and 21), or the gear case cover dowel pins (36 and 37) are loose or damaged, remove them from the cylinder block.
- (8) If the six camshaft bushings (24) are worn in excess of 1.878 inches, scored,

or chipped badly, drive the bushings out of the cylinder block.

- (9) Remove the plugs (9, 10, 23, 25, 26, 33, and 38-40) from the cylinder block.
- (10) Remove the four screws (8-10, fig. 65) and lockwashers (11) that secure the oil pressure relief valve body (2) to the cylinder block; remove the oil pressure relief valve body and gasket (1). Overhaul the oil pressure relief valve as directed in paragraph 157.

*b. Cleaning and Inspection.*

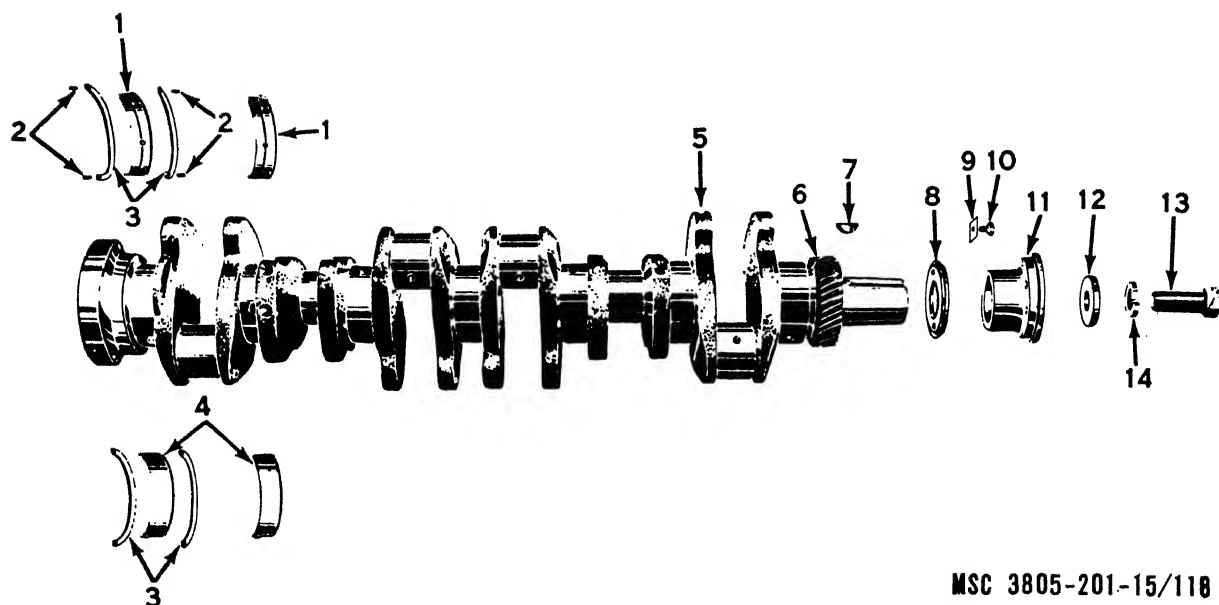
- (1) Steam-clean the cylinder block; dry with compressed air. Scrape all dirt, corrosion, carbon, or particles of old gaskets from the cylinder block. Take care not to scratch the machined surfaces.
- (2) Clean all the oil passages with a rod and cloth or with compressed air.
- (3) If the cylinder liners have been removed, check to see that the air bleed hole (fig. 123) in the bore of cylinder No. 1 is free of obstructions.
- (4) Check the cylinder block for any cracks, leakage in the oil passages, damaged threads, or other defects. Retap any damaged threads.
- (5) Check the cylinder liner counterbore depth in the cylinder block with a dial gage and block-set to read zero on the cylinder block surface. Depress the indicator stem until its point contacts the counterbore ledge. The depth of the ledge should be between 0.30925-inch minimum and 0.31050-inch maximum. Compensate for depths to 0.4035 inch by shimming to provide a measurement in the above range. Take readings at four or more locations on each cylinder counterbore. If there is



MSC 3805-201-15/117

- |                    |         |
|--------------------|---------|
| 1 Vibration damper | 3 Screw |
| 2 Lockplate        |         |

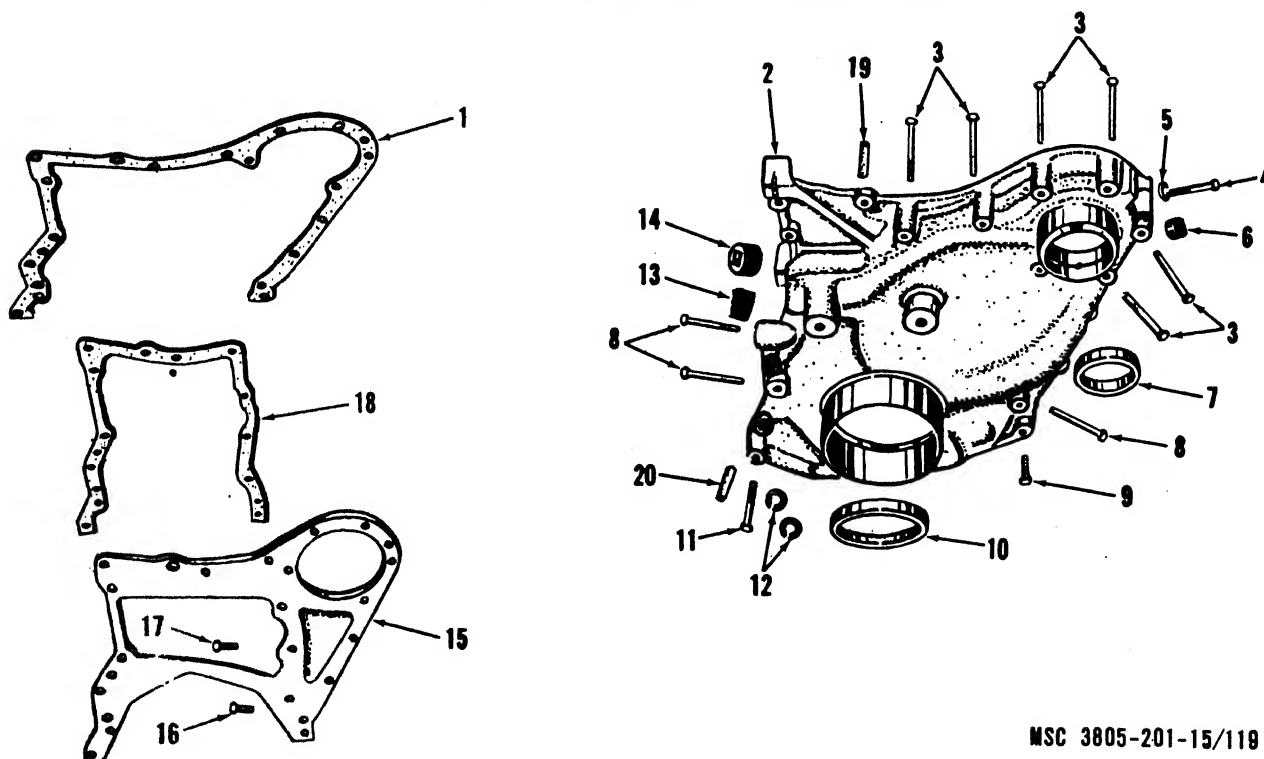
Figure 117. Vibration damper, exploded view.



MSC 3805-201-15/118

- |                           |                           |                            |                         |
|---------------------------|---------------------------|----------------------------|-------------------------|
| 1 Upper main bearing half | 4 Lower main bearing half | 7 Vibration damper hub key | 11 Vibration damper hub |
| 2 Dowel pins              | 5 Crankshaft              | 8 Crankshaft oil slinger   | 12 Crankshaft retainer  |
| 3 Thrust rings            | 6 Crankshaft pinion gear  | 9 Lockplate                | 13 Retainer screw       |
|                           |                           | 10 Screw                   | 14 Lockwasher           |

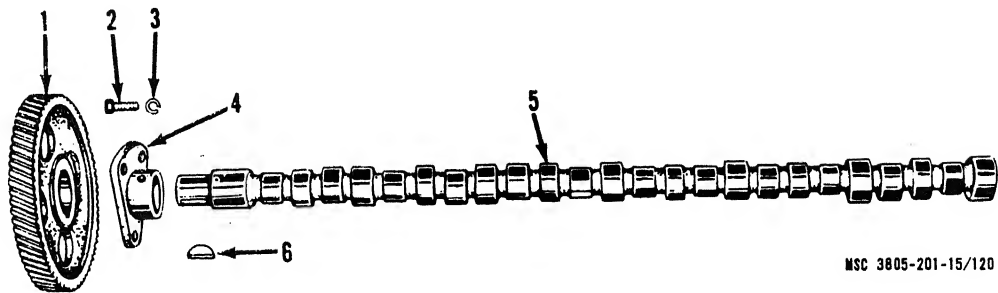
Figure 118. Crankshaft and main bearings, exploded view.



MSC 3805-201-15/118

- |                             |                            |                       |                              |
|-----------------------------|----------------------------|-----------------------|------------------------------|
| 1 Gear housing cover gasket | 6 Plug                     | 11 Screw              | 17 Screw                     |
| 2 Gear housing cover        | 7 Accessory drive oil seal | 12 Lockwasher         | 18 Gear housing plate gasket |
| 3 Screw                     | 8 Screw                    | 13 Plug               | 19 Dowel pin                 |
| 4 Screw                     | 9 Screw                    | 14 Plug               | 20 Dowel pin                 |
| 5 Lockwasher                | 10 Crankshaft oil seal     | 15 Gear housing plate |                              |
|                             |                            | 16 Screw              |                              |

Figure 119. Gear case cover, disassembled view.



MSC 3805-201-15/120

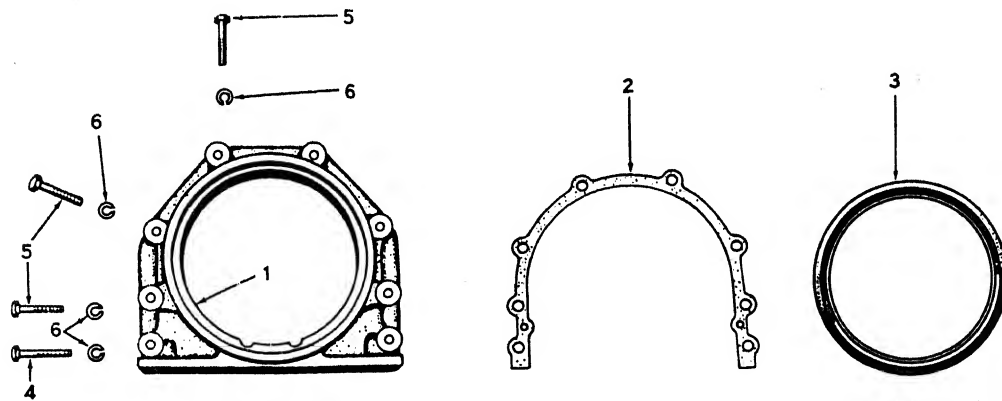
1 Camshaft gear  
2 Screw

3 Lockwasher

4 Camshaft front bearing

5 Camshaft  
6 Camshaft gear key

Figure 120. Camshaft, exploded view.



MSC 3805-201-15/121

1 Cylinder block rear cover

2 Gasket  
3 Rear cover oil seal

4 Screw  
5 Screw

6 Lockwasher

Figure 121. Cylinder block rear cover, exploded view.

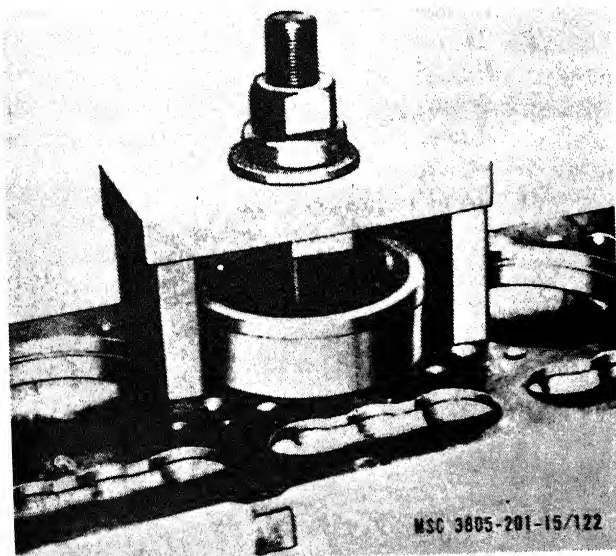


Figure 122. Removing cylinder lining from cylinder block.

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a variation of more than 0.001 inch, the inner edge of the counterbore is lower than the outer edge, or the inner edge is more than 0.00075 inch higher than the outer edge (fig. 124),

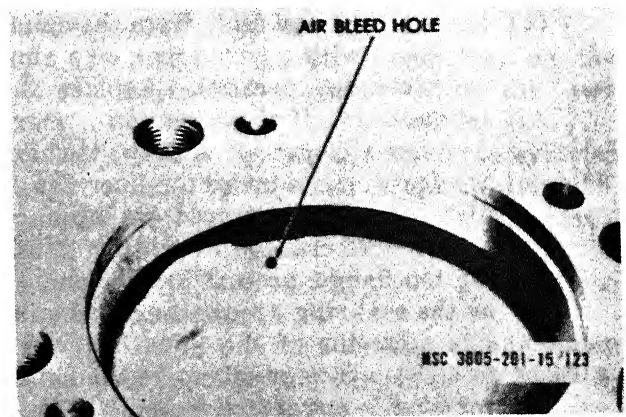
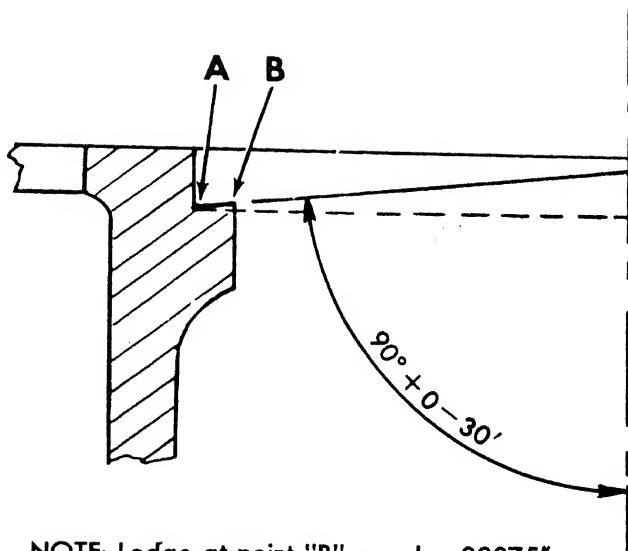


Figure 123. Cylinder No. 1 air bleed hole.



NOTE: Ledge at point "B" may be .00075" higher, but no lower than at point "A".

MSC 3805-201-15/124

Figure 124. Cylinder counterbore, cross-sectional view.

the counterbore will have to be reconditioned with a counterboring tool or by lapping with the cylinder liner. To lap the cylinder liner flanges and the counterbore in the cylinder block, place grade A grit lapping compound on the counterbore ledge. Insert the cylinder liner, apply light even pressure, and rotate one complete revolution; then lap in 30° strokes. Add a few drops of lubricating oil every two or three revolutions to keep the compound moist. Remove all lapping compound; apply a light coat of Prussian blue to the cylinder liner to check the seat (fig. 125).

- (6) Remove rust and scale from the cylinder liners with a wire brush or a similar cleaning operation. Replace the cylinder liner if the corrosion is more than one-sixteenth inch deep; if there are dents or pits under the liner flange that cannot be removed by lapping; if there are cracks in the liner under the top flange, around the bottom, or by the seal ring grooves; or if the inside diameter of the liner has worn to 4.130 inches or more. If the cylinder liner is not defective and is within the wear limits listed above, remove

the worn ridge with a ridge cutter; remove the glaze by honing.

- (7) Check the main bearing bore alignment. Position the main bearing caps (17 and 19, fig. 111) in their proper order on the cylinder block (11); secure with the main bearing screws (20). Tighten the screws to 30 to 35 foot-pounds with a torque wrench; scribe the screws and caps and advance each screw 60° or one hex to operating tension. Use a 4.1225-inch outside diameter checking bar as shown in figure 126 to check the main bearing bore alignment. The bar should pass through all seven bores and turn freely unless the caps are not properly tightened, burs have not been removed, or bearing caps are distorted. If it is determined that a main bearing cap has been distorted and prevents the checking bar from passing through, mark the block for reaming. Use a reaming tool to ream main bearings.

c. Reassembly.

- (1) Install the plugs (9, 10, 23, 25, 26, 33, and 38-40, fig. 111) in their proper places on the cylinder block.
- (2) If the camshaft bushings (24) were removed, position a new bushing on the driving mandrel with the oil hole properly aligned; install the bushings as shown in figure 127.
- (3) If any of the dowel pins (3, 8, 16, 21, 22, 36, and 37, fig. 111) were removed from the cylinder block, install the dowel pins in their proper positions.

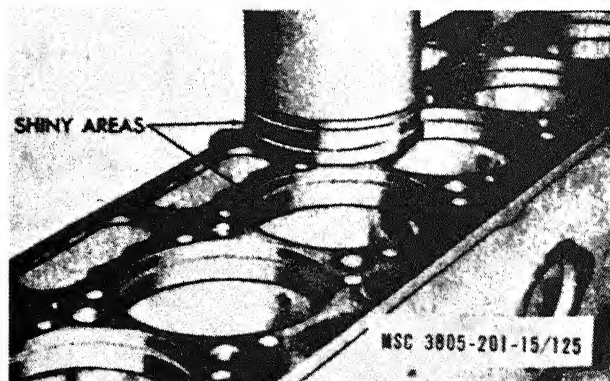


Figure 125. Cylinder liner flange and counterbore after lapping.



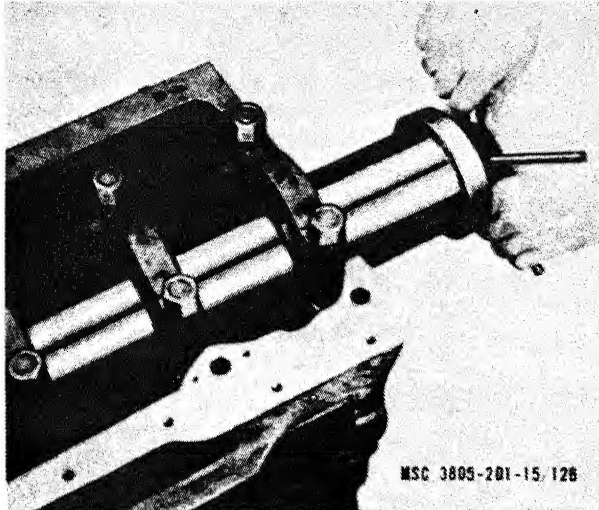


Figure 126. Checking main bearing bore alinement.

- (4) Install the drain cock (34) on the cylinder block.
- (5) Position the water header side cover (12) and gasket (15) on the cylinder block; secure with the two screws (13) and lockwashers (14).
- (6) Position the water header end cover (30) and gasket (32) on the cylinder block; secure with the two screws (31) and lockwashers (14).
- (7) Position the oil transfer connection (4) and gasket (7) on the cylinder block; secure with the four screws (5). Install the plug (6) in the connection.
- (8) Install the cylinder liners (1), two packing rings (2), and pistons in each cylinder as directed in paragraph 234j through r.
- (9) Position the oil pressure relief valve body (2, fig. 65) and gasket (1) on the cylinder block; secure with the four screws (8-10) and lockwashers (11).

## 230. Crankshaft

### a. Removal and Disassembly.

- (1) Remove the crankshaft (5, fig. 118) from the cylinder block as directed in paragraph 227.
- (2) Remove the two screws (10) and lockplates (9) that secure the oil slinger (8) to the crankshaft; remove the oil slinger.
- (3) If it is necessary to remove the crank-

shaft pinion gear (6), attach a gear puller and apply 75 to 110 foot-pounds on the puller screw. Heat the gear with a blow torch between 300° F. and 400° F. to make it expand and easier to pull; remove the gear and the key (7).

### b. Cleaning and Inspection.

- (1) Use a rod and rag, as in cleaning a rifle barrel, to completely clean the oil passages in the crankshaft.
- (2) Inspect the crankshaft for any cracks, nicks, scored bearing surfaces, or poor finish on journals. Measure the crankshaft for wear of the connecting rod journals to less than 2.622-inch outside diameter, or wear of the main bearing journals to less than 3.872-inch outside diameter. If the journals are worn, scored, or poorly finished, the crankshaft can be reground to the next standard undersize if there are no other defects.
- (3) If the crankshaft gear was not removed at disassembly for replacement, inspect the gear for cracked, chipped, or excessively worn gear teeth or other damage.
- (4) Inspect the main bearing shells; replace those which are chipped, flaked, scored, or worn to less than 0.1216 inch thick. A comparator can be used to check against new bearings for wear greater than 0.002 inch.

### c. Reassembly.

- (1) Position the hub key (7, fig. 118) on the crankshaft (5), heat the crankshaft pinion gear (6) to 400°F, align the key slot, and drive the gear onto the crankshaft with tubing.
- (2) Position the oil slinger (8) on the crankshaft; secure with the two screws (10) and lockplates (9).
- (3) Install the crankshaft in the cylinder block as directed in paragraph 236.

## 231 Connecting Rod and Piston Assemblies

### a. Disassembly.

- (1) Remove the connecting rod and piston assemblies from the cylinder block as directed in paragraph 227.

Note. Disassemble each of the six connect-



Figure 127. Installing camshaft bushings.

ing rod and piston assemblies as directed below.

- (2) Remove the two retaining rings (10, fig. 128) that retain the piston pin (12) in the piston (11); remove the piston pin.

*Note.* Heat aluminum pistons in hot water before removing the piston pins. This will permit the pin to be pushed out easily without distorting the piston.

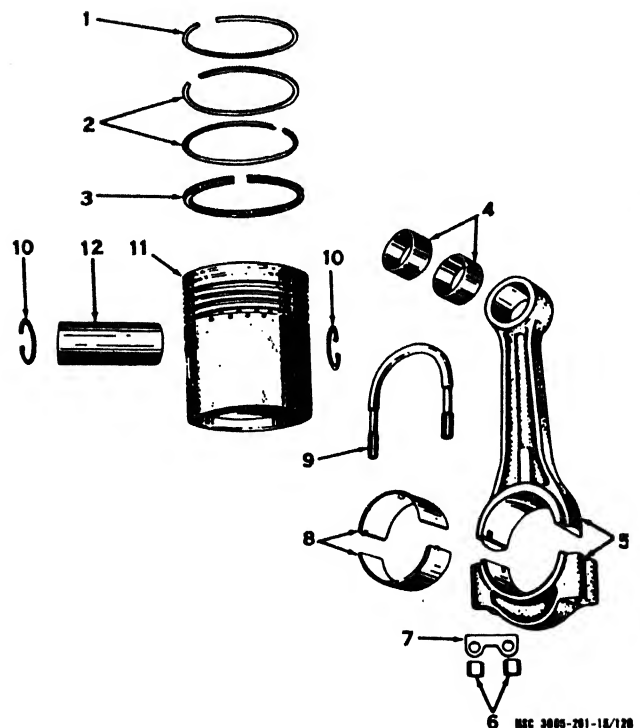
- (3) If the connecting rod piston pin bushings (4) require replacement, press them out with a mandrel and block in an arbor press.
- (4) Remove the piston rings (1 through 3) from the piston.

#### b. Cleaning and Inspection.

- (1) Thoroughly clean all the parts in an approved cleaning solvent; dry with compressed air. Scrape the carbon from the parts if required; take care not to scratch or nick any machined surfaces.
- (2) With the connecting rod bearing removed, assemble the connecting rod caps and tighten the U-bolt nuts alternately in 5-pound increments to the operating tension of 30 foot-pounds. Check the crankpin bore with a dial bore gage or with inside micrometers. The bore must be 2.773 to 2.7725 inches to provide the correct bearing crush; the out-of-round wear should not exceed 0.002 inch.
- (3) Use a fixture to check the connecting rod alignment. The misalignment must not be greater than 0.004 inch when

the connecting rod is turned 180° and replaced in the fixture.

- (4) The connecting rod pin bushings should be checked for scoring, damage, and wear in excess of the maximum 1.5015-inch inside diameter.
- (5) Inspect the connecting rod bearing shells; replace if flaked, chipped, scored, or worn thinner than 0.071 inch.
- (6) Check the piston pin for scoring or wear to less than 1.4978-inch outside diameter.
- (7) Check the pistons for cracks or scoring, the piston pin bore for wear to more than 1:500-inch inside diameter, and the piston skirt diameter at 70° F. (standard pistons) for wear to less than 4.1185-inch outside diameter. Check the piston top and second ring grooves for excessive wear by insert-



- |                                      |                              |
|--------------------------------------|------------------------------|
| 1 Compression ring (chrome)          | 6 Nut                        |
| 2 Compression ring (plain)           | 7 Lockplate                  |
| 3 Oil control ring                   | 8 Connecting rod bearing     |
| 4 Connecting rod piston pin bushings | 9 U-bolt                     |
| 5 Connecting rod and cap             | 10 Piston pin retaining ring |
|                                      | 11 Piston                    |
|                                      | 12 Piston pin                |

Figure 128. Piston and connecting rod assembly, disassembled view.

ing a new ring and checking to see that a 0.006-inch feeler gage enters the groove beside the ring.

- (8) Check the piston ring gap by inserting each compression ring squarely in operating position in its mating cylinder and measuring the gap with a feeler gage. The gap must be within 0.013-inch minimum and 0.023-inch maximum. If necessary, file the ends of the rings to obtain the minimum gap.
- (9) Replace all parts that are defective or worn in excess of the wear limits given.

*c. Reassembly.*

*Note.* Reassemble each of the six connecting rod and piston assemblies as directed below.

- (1) If the connecting rod piston pin bushings (4, fig. 128) were removed, press two new bushings into position, one from each side, to a point where they are flush with the milled side surfaces of the connecting rod (5).
- (2) Heat the piston in boiling water; push the piston pin (12) into place through the piston (11) and the connecting rod before the piston cools.
- (3) Install the two retaining rings (10) in position to secure the piston pin in the piston.
- (4) Lubricate the piston and the rings (1-3) with clean lubricating oil; position the rings in their proper grooves on the pistons.
- (5) Install the assembled connecting rod and pistons in the cylinder block as directed in paragraph 236.

## **232. Rocker Levers**

*a. Disassembly.*

- (1) Remove the rocker levers and shaft from the engine as directed in paragraph 227.
- (2) Slide the seven rocker shaft bearings (3 and 5-7, fig. 129), the six intake rocker levers (20), and the six injector rocker levers (14), and the six exhaust rocker levers (11) off the rocker lever shaft (2). Remove the rocker shaft expansion plugs (1) from the end bearings (3).
- (3) If any of the rocker lever bushings (10, 15, or 19) are scored, damaged,

or worn more than 1.265-inch inside diameter, press them out of the rocker levers.

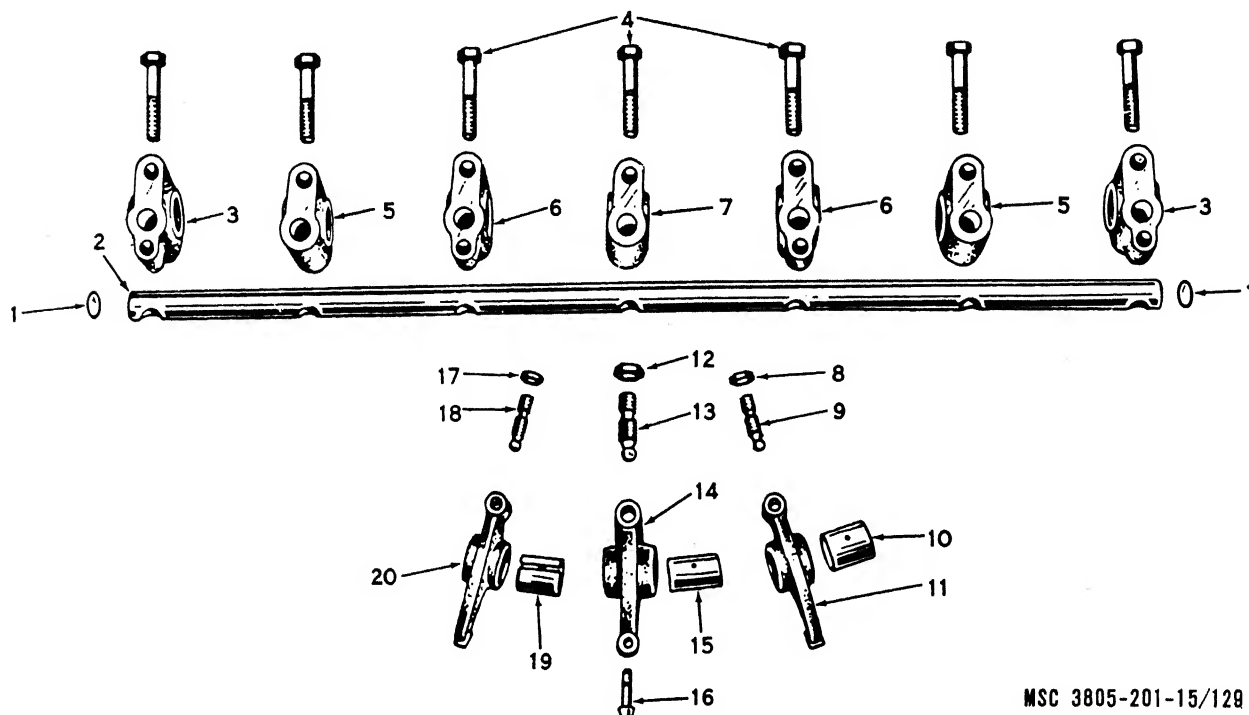
- (4) Remove the nuts (8 and 17) that secure the intake and the exhaust rocker lever adjusting screws (18 and 9); remove the rocker lever adjusting screws.
- (5) Remove the injector rocker lever sockets (16) from the injector rocker levers.
- (6) Remove the nuts (12) that secure the injector rocker lever adjusting screws (13); remove the injector rocker lever adjusting screws.

*b. Cleaning and Inspection.*

- (1) Clean all the parts with an approved cleaning solvent. Be sure that all the oil passages in the rocker levers, rocker lever sockets, and the rocker lever shaft are clear.
- (2) Check all the rocker lever bushings for scoring, damage, or excessive wear. Replace any bushings that are scored, damaged, or worn more than 1.265-inch inside diameter.
- (3) Check the roundness of the ball ends of the rocker lever adjusting screws with a  $\frac{1}{4}$ -inch radius gage. Replace the adjusting screws if they are worn flat.
- (4) Check the injector rocker lever sockets with a radius gage or by coating the ball end of a good push rod with prussian blue as shown in figure 130 and observing the contact area at the bottom of the socket. Replace if excessively worn.
- (5) Check the rocker lever bearings for damage or excessive wear.
- (6) Check the rocker lever shaft for scoring or damage. Replace it if it is damaged or worn to less than 1.122-inch diameter.

*c. Reassembly.*

- (1) Install the injector rocker lever adjusting screws (13, fig. 129) on the injector rocker levers (14); secure with the nuts (12).
- (2) Install the injector rocker lever sockets (16) on the injector rocker levers.
- (3) Install the intake rocker lever adjusting screws (18) on the intake rocker



- |   |   |   |  |
|---|---|---|--|
| 1 Rocker shaft expansion plug                     | 6 Rocker shaft bearing (No. 3 and No. 5 position) | 10 Exhaust rocker lever bushing             | 16 Injector rocker lever socket            |
| 2 Rocker lever shaft                              | 7 Rocker shaft bearing (No. 4 position)           | 11 Exhaust rocker lever adjusting screw nut | 17 Intake rocker lever adjusting screw nut |
| 3 Rocker shaft bearing (No. 1 and No. 7 position) | 8 Exhaust rocker lever adjusting screw            | 12 Injector rocker lever adjusting screw    | 18 Intake rocker lever adjusting screw     |
| 4 Screw   | 9 Exhaust rocker lever adjusting screw            | 13 Injector rocker lever adjusting screw    | 19 Intake rocker lever bushing             |
| 5 Rocker shaft bearing (No. 2 and No. 6 position) |   | 14 Injector rocker lever bushing            | 20 Intake rocker lever                     |

Figure 129. Rocker levers, disassembled view.

levers (20); secure with the nuts (17). Install the exhaust rocker lever adjusting screws (9) on the exhaust rocker

levers (11); secure each with a nut (8).

- (4) If any of the rocker lever bushings 10, 15, or 19) have been removed, press a new bushing into place, taking care that the oil holes in the bushing and the lever will be aligned. Use a 60° cutter in a slow speed drill press to chamfer each end of the bushing, being careful not to cut the lever. Place soft soap in the oil hole and use a boring machine to bore the bushing out to 1.1245- to 1.1255-inch diameter. Use compressed air to blow the soap out of the lubricating oil holes.
- (5) Position the No. 1 and No. 7 position rocker shaft bearings (3, fig. 131), No. 2 and No. 6 position bearings (4), No. 3 and No. 5 position bearings (1), No. 4 position bearing (2), the six intake rocker levers (I), the six exhaust

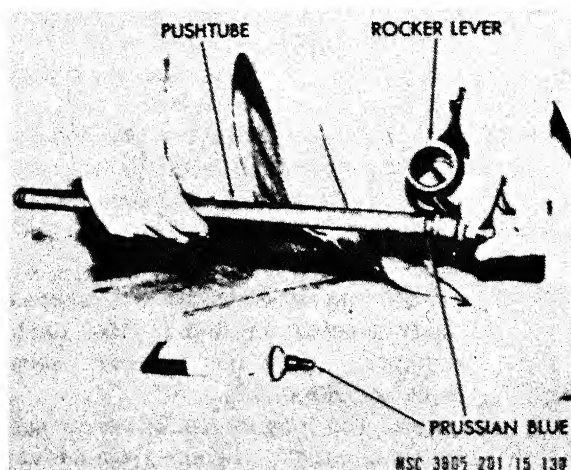
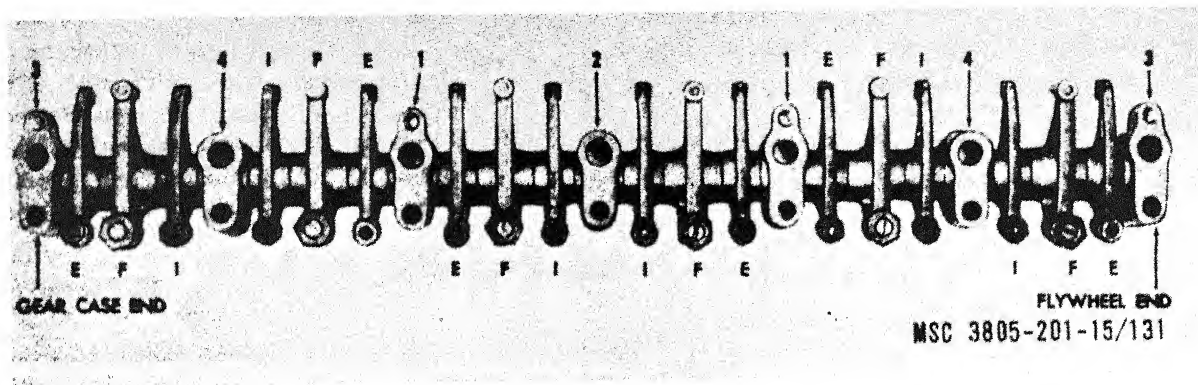


Figure 130. Checking rocker lever socket wear.



- |  |   |   |   |
|--|---|---|---|
| <p>1 No. 3 and No. 5 position rocker shaft bearings</p> <p>2 No. 4 position rocker shaft bearing</p> | <p>3 No. 1 and No. 7 position rocker shaft bearings</p> | <p>4 No. 2 and No. 6 position rocker shaft bearings</p> | <p>E Exhaust rocker lever</p> <p>F Injector rocker lever</p> <p>I Intake rocker lever</p> |
|--|---|---|---|

Figure 131. Assembly of rocker lever shaft.

rocker levers (E), and the six injector rocker levers (F) on the rocker lever shaft as shown in figure 131.

- (6) Install the assembled rocker levers and shaft on the engine as directed in paragraph 236.

### 233. Tappet Assemblies

#### a. Disassembly.

- (1) Remove the tappet assemblies from the cylinder block as directed in paragraph 227.

*Note.* Disassemble each of the 12 valve tappet assemblies as described below.

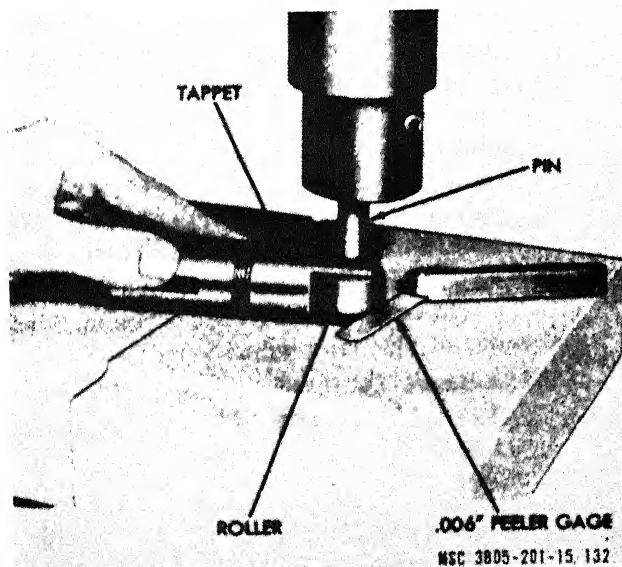


Figure 132. Pressing roller pin from tappet.

- (2) Remove the pinlock (4, fig. 113) that secures the tappet roller pin (3).
- (3) Place a 0.006-inch shim between the bottom side of the roller (2) and the tappet (5); press the roller pin from the tappet as shown in figure 132.
- (4) Remove the valve tappet guide sleeve (6, fig. 113) from the tappet.

*Note.* Disassemble each of the six injector tappet assemblies as directed below.

- (5) Remove the lockwire (11) that secures the injector tappet roller pin (12).
- (6) Place a 0.006-inch shim between the bottom side of the injector tappet roller (13) and the tappet (10); press the roller pin from the injector tappet as shown in figure 132.
- (7) Remove the injector tappet guide sleeve (9, fig. 113) from the injector tappet.

#### b. Cleaning and Inspection.

- (1) Thoroughly clean the parts with cleaning solvent; dry with compressed air.
- (2) Check the roller and the pins for scoring, cracks, damage, or visible wear.
- (3) The wear limits for the valve tappet rollers are 1.059-inch minimum outside diameter and 0.505-inch maximum inside diameter; the minimum outside diameter for the valve tappet pin is 0.4985 inch.
- (4) The wear limits for the injector tappet rollers are 1.121-inch minimum outside diameter and 0.5675-inch max-

imum inside diameter; the minimum outside diameter for the injector tappet pin is 0.561 inch.

- (5) Inspect the tappets for cracks, scoring, or wear to less than 1.184-inch outside diameter for the valve tappets, or wear to less than 1.309-inch outside diameter for injector tappets.
- (6) Check each of the exhaust, intake, and injector push rods for scratching, galling, excessive wear, and true spherical contours.

*c. Reassembly.*

*Note.* Reassemble each of the 12 valve tappet assemblies as directed below.

- (1) Aline the slot of the valve tappet guide sleeve (6, fig. 113) with the slot of the tappet (5); compress and install the tappet guide sleeve.
- (2) Position the tappet roller (2) on the tappet and place a 0.006-inch shim between the bottom side of the roller and the tappet as shown in figure 132; aline the holes and press the tappet roller pin (3, fig. 113) into position.
- (3) Secure the tappet roller pin in position with the pinlock (4).

*Note.* Reassemble each of the six injector tappet assemblies as directed below.

- (4) Aline the slot of the injector tappet guide sleeve (9) with the slot of the injector tappet (10); compress and install the injector tappet guide sleeve.
- (5) Position the injector tappet roller (13) on the injector tappet (10) and place a 0.006-inch shim between the bottom side of the roller and the tappet as shown in figure 132; aline the holes and press the injector tappet roller pin (12, fig. 113) into position.
- (6) Secure the roller pin in position with the lockwire (11).
- (7) Install the tappet assemblies in the cylinder block as directed in paragraph 236a1.

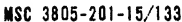
## **234. Lubricating Oil Pump and Suction Tube Assemblies**

*a. Disassembly.*

- (1) Remove the assembled lubricating oil pump and suction tube assemblies from the engine as directed in paragraph 227.

- (2) Remove the four screws (24 and 25, fig. 116) and copper washers (26) that secure the suction tube (23) to the double lubricating pump; remove the suction tube and gasket (27). Remove the suction screen support and suction screen from the suction tube.
- (3) Remove the three screws (19 and 20) and lockplates (21) that secure the suction tube assembly (10) to the oil pump; remove the suction tube and gasket (22). Remove the suction screen support (14) and suction screen (13) from the suction tube.
- (4) Remove the two screws (26 and 28, fig. 133) and lockplates (27) that secure the lubricating pump housing (25) to the lubricating pump housing (15); remove the lubricating pump housing (25) and gasket (20). If the dowel pin (24) is loose or damaged, remove it from the housing.
- (5) Remove the pump driven gear (30) and scavenger pump idler gear shaft (32) from the pump housing. If the pump driven gear bushings (31) are excessively worn or damaged, press them out of the gear.
- (6) If the pump housing bushing (29) is scored or excessively worn, remove it from the lubricating pump housing.
- (7) Remove the lockwires (3 and 19) from the three screws (2) and the screw (18) that secure the idler gear retainer (1) to the lubricating pump cover (8); remove the screws and idler gear retainer.
- (8) Remove the idler gear (5), thrust washer (7), and idler gear shaft (6) from the lubricating pump cover.
- (9) If the idler gear bushing (4) is scored or excessively worn, press the bushing out of the idler gear.
- (10) Remove the three screws (9), lockplates (10), screw (17), and lockwires (3 and 19) that secure the lubricating pump cover (8) to the pump housing (15); remove the cover and gasket (12). If the dowel pins (14 and 36) are loose or damaged, remove the dowel pins from the housing.

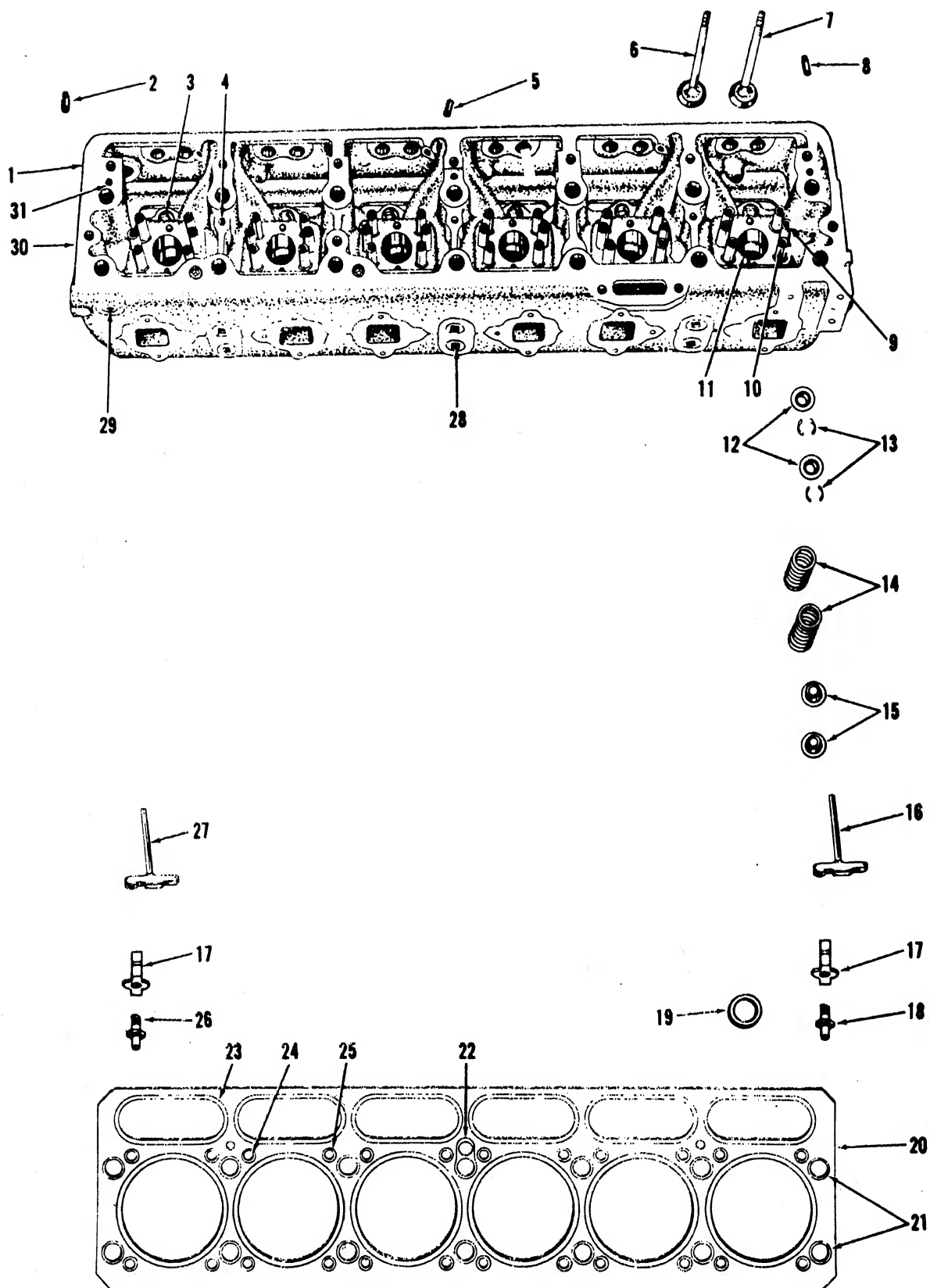




- Figure 133. Lubricating oil pump, exploded view.

- ### c. Reassembly.





MSC 3805-201-15/134

Figure 134. Cylinder head, disassembled view.

1 Cylinder head	10 Intake and exhaust valve guide	17 Crosshead retainer	25 Grommet retainer
2 Dowel pin	11 Injector sleeve	18 Crosshead nut	26 Crosshead adjusting screw
3 Plug	12 Valve spring retainer	19 Valve seat insert	27 Right valve crosshead
4 Plug	13 Half collet	20 Cylinder head gasket	28 Pipe plug
5 Dowel pin	14 Spring	21 Grommet	29 Plug
6 Intake valve	15 Valve spring guide	22 Grommet	30 Fuse plug
7 Exhaust valve	16 Left valve crosshead	23 Ring	31 Dowel pin
8 Oil line dowel pin		24 Grommet	
9 Crosshead guide			

Figure 134—Continued.

- place.
- (2) Position the key (22) on the scavenger pump drive shaft (21); align the slot of the scavenger pump drive gear (23) with the key and press the gear into place.
  - (3) Insert the scavenger pump drive shaft through the bushing of the lubricating pump housing; press the oil pump gear (37) onto the shaft.
  - (4) If the bushings (11) were removed from the lubricating pump cover (8), press new bushings into the cover.
  - (5) Press the oil pump gear (37) into place on the pump drive shaft (13).
  - (6) Insert the pump drive shaft through the bushing on the lubricating pump cover; press the oil pump driven gear (38) onto the pump drive shaft.
  - (7) If the dowel pins (14 and 36) were removed, position new pins on the lubricating pump housing.
  - (8) Position the gasket (12) and lubricating pump cover (8) on the lubricating pump housing; secure with the three screws (9), lockplates (10), and screw (17).
  - (9) If the idler gear bushing (4) was removed, press a new bushing into the idler gear (5).
  - (10) Position the idler gear shaft (6), the thrust washer (7), the idler gear (5), and the idler gear retainer (1) on the lubricating pump cover; secure with the screws (2 and 18).
  - (11) If the bushing (29) was removed from the lubricating pump housing (25), press a new bushing into place.
  - (12) If the bushings (31) were removed from the pump driven gear (30), press a new bushing in flush with the edge on each side of the gear.
  - (13) Install the scavenger pump idler gear shaft (32) into the lubricating pump housing; position the scavenger pump idler gear on the shaft.
  - (14) Replace the dowel pin (24) in the lubricating pump housing if it was removed at disassembly. Position the gasket (20) and the pump housing on the lubricating pump housing; secure with the two screws (28 and 26) and the lockplates (27).
  - (15) Install the lockwire (3) on the lubricating pump screws that are drilled for it.
  - (16) Position the suction screen (13, fig. 116) on the suction tube assembly (10); secure in position with the suction screen support (14).
  - (17) Position the assembled suction tube (10) and screen on the oil pump; secure with the two screws (20), the screw (19), and the three lockplates (21).
  - (18) Position the suction tube (23) on the oil pump; secure with the three screws (25), the screw (24), and washers (26).
  - (19) Install the lubricating oil pump and the suction tubes on the engine as directed in paragraph 236z.

## 235. Cylinder Head

### a. Disassembly.

- (1) Remove the cylinder head from the engine as directed in paragraph 227.  
*Note.* Clean all of the sludge, grease, and dirt from the exterior of the cylinder head prior to disassembly.
- (2) If any of the intake manifold dowel pins (2, fig. 134) or rocker bearing dowel pins (5) are loose or damaged, remove them from the cylinder head (1).
- (3) Remove the crosshead retainer (17) and the assembled crossheads; remove the nut (18) and adjusting screw (26) from each crosshead (16 and 27).

- (4) Use a valve spring compressor to depress the valve spring retainers (12); remove the two half collets (13). Remove the valve spring retainer, the valve spring (14), and the valve spring guide (15) from each of the valves.
  - (5) Remove and number the intake valves (6) and the exhaust valves (7) by their respective positions.
  - (6) If the valve guides (10) are out-of-round or worn beyond the wear limit diameter of 0.345 inch, drive the valve guide out from the underside of the cylinder head.
  - (7) Remove loose or excessively worn valve seat inserts (19) from the cylinder head.
  - (8) Remove damaged or distorted injector sleeves (11) by cutting them from the cylinder head with a  $\frac{3}{8}$ -inch gouge chisel and driving them out from the underside of the cylinder head.
  - (9) Remove the plugs (3, 4, 28, and 29) from the cylinder head.
- b. *Cleaning and Inspection.*
- (1) Thoroughly clean the cylinder head and the parts removed from it with an approved cleaning solvent.
  - (2) Examine the metal alloy fuse plug (30) in the cylinder head for signs of overheating; replace the fuse plug if it is melted or damaged.
  - (3) Check for loose valve seat inserts by



Figure 135. Checking for loose valve inserts.

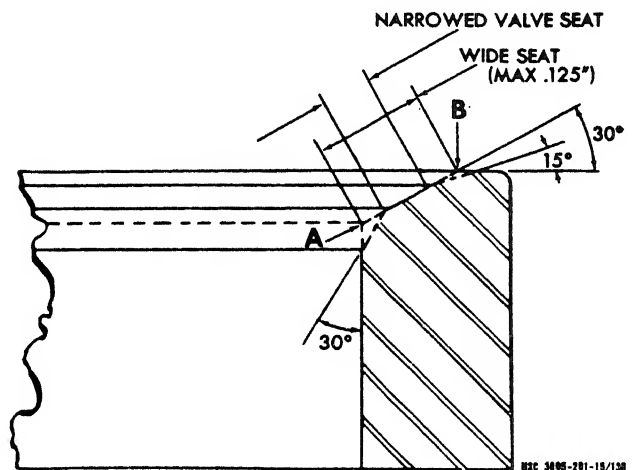


Figure 136. Valve seat, cross-sectional view.

- tapping them lightly as shown in figure 135; replace if the valve seat insert is loose enough to bounce or cannot be reground. The valve seat width should be  $\frac{1}{16}$  to  $\frac{1}{8}$  inch, and the angle of the seat should be 30° as shown in figure 136.
- (4) Check the crosshead guide bore with a small bore gage; replace crosshead guides that are out-of-round or worn to more than 0.378-inch inside diameter.
  - (5) Clean the valves with a buffer and remove any carbon deposits with a scraper. Replace the valve if it is cupped, cracked, or pitted; if the head rim is worn to less than  $\frac{1}{16}$  inch as shown in figure 137; if the stems are scored or worn to less than 0.339-inch diameter; or if the collet recesses are worn so that the half collets do not fit securely. Wet-grind the valves to an exact 30° angle with a grinding wheel of the proper grade, properly dressed to avoid chatter and grind marks. Lapping should not be required, but a small amount is permissible. Pencil-mark the valves as shown in figure 138; drop each line into its respective position and rotate 10°. A true seat is indicated if all of the pencil marks are broken.
  - (6) Check the crossheads for cracks, distortion, or excessive wear and the crosshead stems for scoring, out-of-

round, or wear to less than 0.370-inch diameter.

- (7) Test the valve spring load limits and length in a spring test fixture. The valves should correspond with those given in the following table:

Free length	Load limit	Length
2.364	44 lb 111 lb	2.016 1.610

- (8) Measure the injector cup tip protrusion above the cylinder head surface as shown in figure 139. The injector cup tips should protrude between 0.040 and 0.055 inch. The maximum allowable protrusion is 0.065 inch.
- (9) Resurface the cylinder head if it has been scratched, etched, or worn unevenly. After resurfacing, the cylinder head height must be at least 4.970 inches. Check the injector tip protrusion ((8) above) and install new injector sleeves, if required, to maintain the correct injector tip protrusion.
- (10) Check to see that the oil line dowel shown in figure 140 in the center rocker bearing position is not obstructed. Use compressed air to clean the oil passages.
- (11) Check the ventilators to be sure they are not plugged or obstructed.

**c. Reassembly.**

- (1) Install the plugs (3, 4, 28, and 29, fig. 134) in their respective positions on the cylinder head (1).

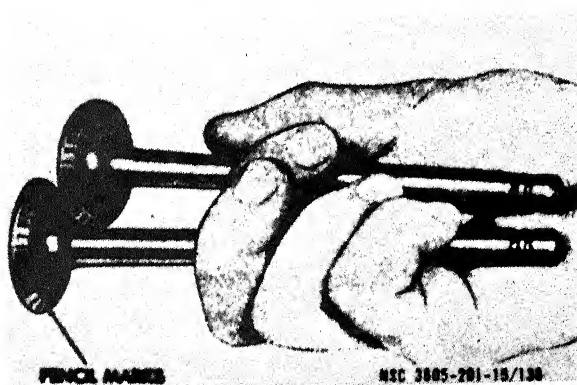


Figure 137. Checking thickness of valve head rim.

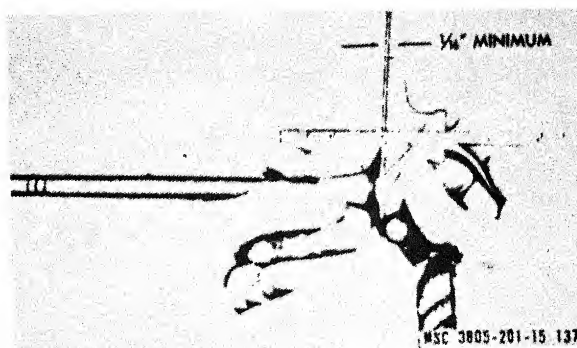


Figure 138. Marking valves to check valve seat.

- (2) If any of the injector sleeves (11) have been removed, press a new injector sleeve into position on the cylinder head (1). Seal the upper part of the injector sleeve with an expanding roller tool set to provide 1.380- to 1.375-inch inside diameter clearance for the injector body. If the injector sleeve protrudes above the bore after the rolling operation, it must be cut off with an endcutter. The injector seat should be cut to provide an injector cup tip protrusion of 0.040 inch to 0.055 inch measured as shown in figure 139.
- (3) To replace the valve seat inserts (19, fig. 134), the counterbore should be enlarged to the next larger oversize and machined 0.006 to 0.010 inch deeper than the insert height to permit peening of the cylinder head to hold the insert. Install the insert and peen in place with a 1/4-inch diameter round end punch.
- (4) Install the valve guides (10) with a driver so the height above the cylinder head surface is 1.240 to 1.260 inches. Ream the valve guides from the bottom side of the cylinder head, using a reamer with a cutting flute diameter of 0.3429 to 0.343 inch.
- (5) Press in new crosshead guides (9); if necessary, ream the guides to 0.3760- to 0.3775-inch inside diameter with a bottom reamer.
- (6) Install the intake valves (6) and the exhaust valves (7) in their respective positions; place the cylinder head face down on a wooden bench or surface

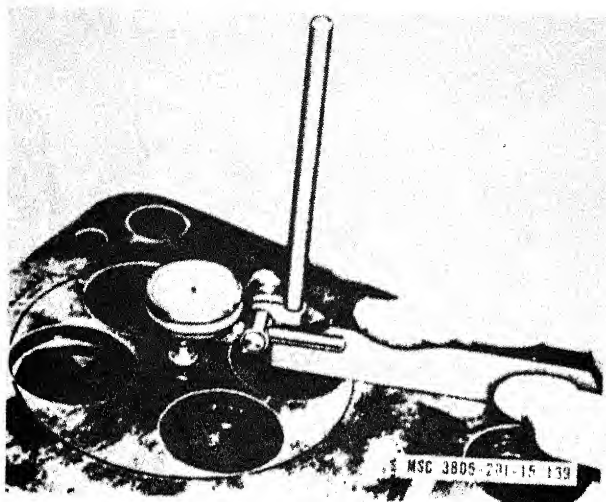


Figure 139. Measuring injector cup tip protrusion.

to prevent marring of the milled surface.

- (7) Install the valve spring guides (15), the valve springs (14), and the valve spring retainers (12); compress the spring with a valve spring compressor and install the two half collets (13) that retain each valve spring.

*Note.* It may be necessary to use spacers under the valve spring guides to obtain the proper valve spring length. Grinding the valves, resurfacing the cylinder head, or replacing the valve seats would reduce the spring tension and cause weak spring action.

- (8) Install the adjusting screw (26) on each of the valve crossheads (16 and



Figure 140. Cylinder head oil line dowel.

27); position the crosshead retainer (17) over the top of the adjusting screw and install the nut (18) finger tight. Position the crossheads so the adjusting screws are toward the edge of the cylinder head and the offsets align with the valve stems; secure the crosshead retainers over the valve spring retainers.

- (9) Replace any of the dowel pins (2 and 5) that were removed from the cylinder head.
- (10) Install the assembled cylinder head on the engine as directed in paragraph 236am and an.

### 236. Engine Reassembly

a. Position the assembled cylinder block upside down on a suitable stand to begin reassembly.

b. Install the upper main bearing halves (1, fig. 118) in their respective positions, engaging the locking tang with the recess in the block. Coat the main bearing halves thoroughly with lubriplate.

c. Lift the crankshaft (5) into position, using rope or rubber-covered hooks to protect the bearing surfaces. Roll the upper half thrust rings (3) into position beside the No. 7 bearing.

d. Install the lower main bearing halves (4) on their respective bearing caps (17 and 19, fig. 111). Position the thrust rings (3, fig. 118) on the pins (2) of the No. 7 bearing cap (17, fig. 111).

e. Coat the lower main bearing halves with lubriplate and position the bearing caps in their respective positions on the cylinder block. Lubricate the threads of the screws (20) with clean lubricating oil prior to installation.

f. Position the lockplates (18); install the screws and tighten to 160 foot-pounds to set the bearings, caps, and lockplates. Loosen the screws completely; retighten to a torque of 30 to 35 foot-pounds. Scribe the position of the screws in line with one hex corner; tighten the screws alternately to advance each screw 60°, or one hex, from the above scribed position.

g. To check the crankshaft end clearance, attach a dial indicator to the cylinder block so that the contact point is against the crankshaft flange face. With a small bar, pry the crankshaft toward one end. Set the gage and pry



Figure 141. Applying lubriplate to connecting rod bearings.

toward the other end. The minimum end clearance is 0.004 inch and the maximum is 0.022 inch. If the end clearance is within these limits, lock the screws with the lockplates. If the end clearance exceeds the maximum, oversize thrust rings will have to be installed.

h. Coat the cylinder block rear cover oil seal (3, fig. 121) with lubriplate; position the seal on the rear cover (1) with the open side down; press it into position flush with the rear cover with a flat plate larger than the seal diameter.

i. Remove all burrs from the outside of the crankshaft flange and install a pilot tool to install the cylinder block rear cover and seal without damage. Cement the cylinder block rear cover gasket (2) in place and install the rear

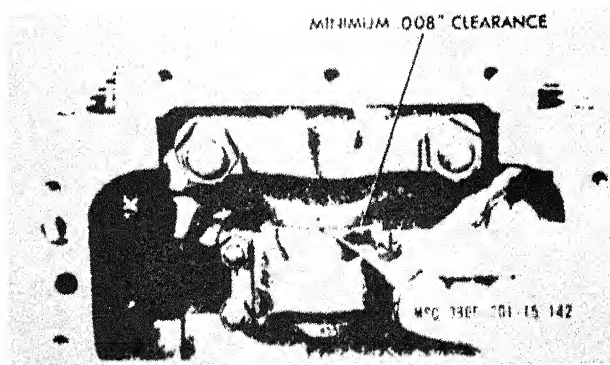


Figure 142. Measuring clearance between connecting rod and crankshaft.

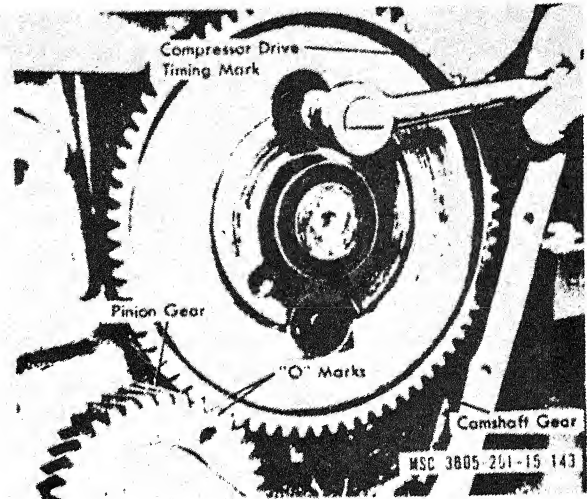


Figure 143. Installing the camshaft.

cover; secure with the eight screws (4 and 5) and lockwashers (6).

j. Place each cylinder liner (1, fig. 111) in its bore of the cylinder block without packing rings or shims to determine the cylinder liner protrusion. Each cylinder liner must have a protrusion between 0.0045 and 0.00675 inch, with less than 0.001-inch variation between adjacent cylinder liners. Use spacers and cylinder head screws to hold each liner in position and measure at four equidistant points. Use shims if required to obtain the proper amount of cylinder liner protrusion.

k. Lubricate the two cylinder liner packing rings (2) and the machined surfaces of the cylinder liner bore in the cylinder block; position the packing rings on the cylinder liner. Press the cylinder liners into their respective bores.

l. Remove the nuts, U-bolts, and connecting rod cap from the connecting rod. Install the halves of the connecting rod bearing (8, fig. 128) on the connecting rod and cap (5); apply lubriplate to the bearing halves as shown in figure 141.

m. Check that the piston rings are installed in the proper grooves of the piston and the ring gaps are staggered so they are not in line with each other or with the piston pin.

n. Lubricate the bore of the cylinder liner and the assembled piston and liner with clean lubricating oil.

o. Compress the rings with a band-type ring compressor; push the assembled piston into its respective cylinder liner bore. The numbered side of the connecting rod should be toward



the camshaft side of the cylinder block. Position the two U-bolts (9, fig. 128) and the proper connecting rod cap on the connecting rod; install the two lockplates (7) and the four nuts (6).

p. Tighten the nuts alternately in 5-foot-pound steps to 30 foot-pounds. Loosen the nuts completely. Retighten in 5-foot-pound steps to 30 foot-pounds, tapping the cap a light blow with a plastic or rawhide hammer to obtain proper alinement. Mark the position of each nut. Advance each nut 60°, in 30° steps, to obtain proper operating tension. Check to see if any of the nuts break loose with a torque less than 38 foot-pounds; if they come loose, replace the U-bolt; otherwise, lock them in position with the lockplate.

q. Check for a minimum clearance of 0.008 inch between the connecting rod and the crankshaft journal as shown in figure 142.

r. Assemble each of the remaining five pistons and connecting rods in the cylinder block as directed in l through q above.

s. Position the gear housing plate gasket (18, fig. 119) and the gear housing plate (15) over the dowels (19 and 20) on the cylinder block; secure with the screws (17 and 16).

t. Lubricate the camshaft and the camshaft bushings in the cylinder block with clean lubricating oil; rotate the camshaft (5, fig. 120) while inserting it into the cylinder block to allow the lobes of the cam to pass through the camshaft bearings. Aline the "O" timing mark on the camshaft gear with the "O" timing mark on the crankshaft pinion gear, as shown in figure 143. Position the front camshaft bearing on the cylinder block; secure with the three screws (2, fig. 120) and lockwashers (3).

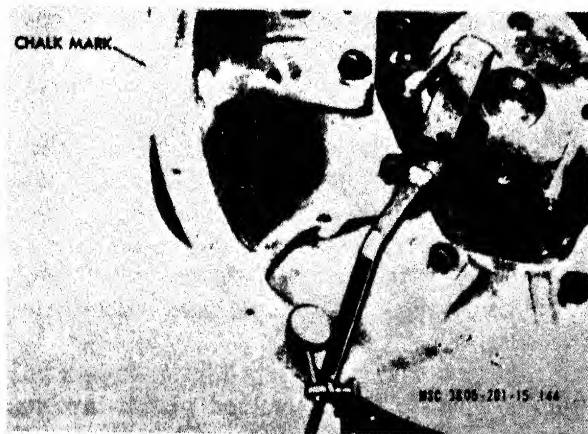


Figure 144. Measuring flywheel housing bore.

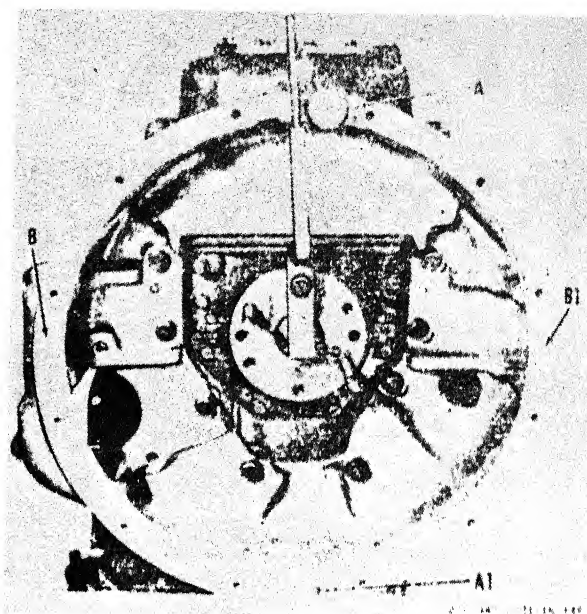


Figure 145. Indicating face of flywheel housing.

u. Press the accessory drive oil seal (7, fig. 119) and the crankshaft oil seal (10) into their positions on the gear housing cover (2). Position the gear housing cover gasket (1) and the gear housing cover on the cylinder block; secure with the screws (3, 8, 9, and 11) and the lockwashers (12).

v. Install the plugs (6, 13, and 14) in their respective positions on the gear housing cover.

w. Position the engine support trunion on the gear cover; tighten the bolt.

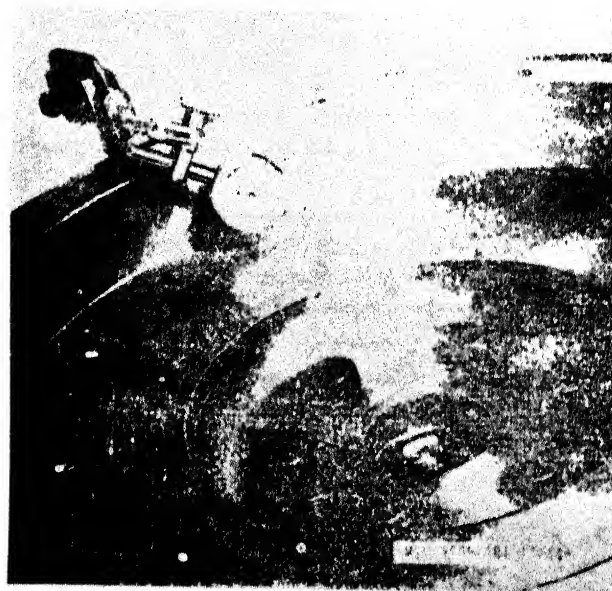


Figure 146. Indicating flywheel bore.



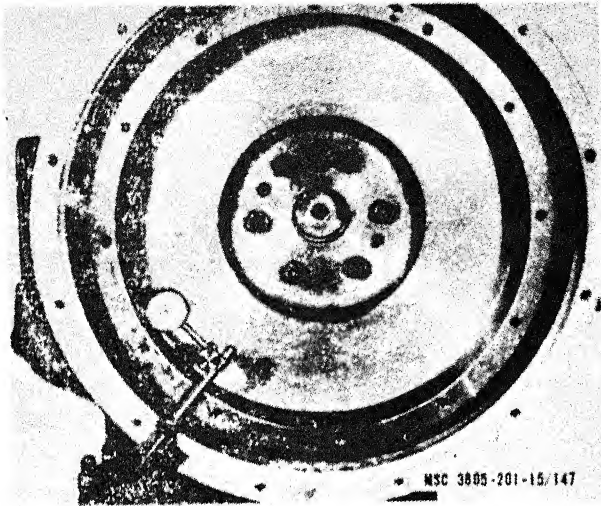


Figure 147. Indicating flywheel face.

x. Position the vibration damper hub key (7, fig. 118) on the crankshaft (5); mount the vibration damper hub (11). Install the retainer (12), lockwasher (14), and screw (13) to secure the vibration damper hub on the crankshaft; tighten the screws to a torque of 120 to 140 foot-pounds.

y. Position the vibration damper (1, fig. 117) on the vibration damper hub; secure with the six screws (3) and three lockplates (2).

z. If the two dowel pins (39, fig. 133) were removed, install new pins for the lubricating oil pump. Position the assembled lubricating oil pump and the suction tubes on the cylinder block, taking care that the gear is engaged; secure with the three screws (33 and 34) and the lockplate (35).

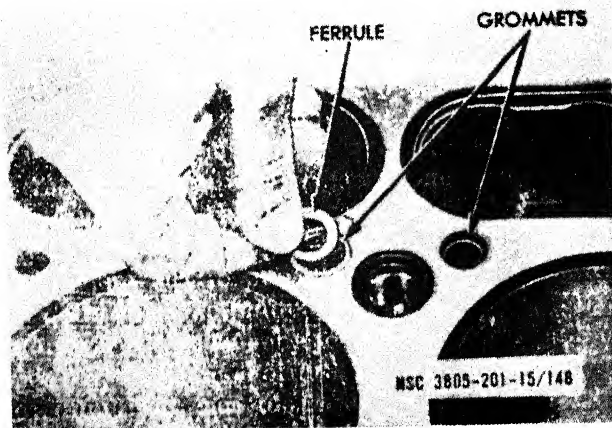


Figure 148. Installing grommets in cylinder head gasket.

aa. Position the two brackets (7, fig. 116) on the oil suction tube studs; secure with the two nuts (12) and washers (11). Install the two screws (8) and the lockwashers (9) that secure the oil suction tube brackets to the cylinder block.

ab. Position the oil drain tube (28) on the cylinder block; secure with the two screws (29).

ac. Shellac the gasket (4) to the oil pan (18); position the assembled oil pan over the dowels on the cylinder block. Secure the oil pan to the cylinder block with the 26 screws (1, 5, 6, 30, and 31), lockwashers (2), and plain washers (3).

ad. Cement the gasket (7, fig. 114) in the camshaft counterbore of the flywheel housing (5). Position the flywheel housing over the dowels on the cylinder block; secure to the cylinder block with the eight screws (3) and lockwashers (4); secure to the oil pan with the four screws (11), lockwashers (12), and plain washers (13).

ae. Fasten an indicator gage to the crankshaft flange as shown in figure 144 to indicate the bore of the housing; make four chalk marks at point A, A1, B, and B1 as shown in figure 145. Take readings at the four points to determine the bore runout; if the runout exceeds 0.010 inch, remove the housing and the mounting dowels. Remount the housing without the dowel pins (6, fig. 114) and loosen the screws to shift the housing slightly into position. When readings within limits are obtained, redowel to the smallest permissible oversize.

af. Shift the gage to the position shown in figure 145 to indicate the face of the flywheel housing. Turn the crankshaft to various positions and take up the crankshaft end play in the same direction each time before reading the gage. The face runout should not exceed 0.008 inch.

ag. If the dowel pins (16, fig. 114) were removed from the crankshaft, or if a new flywheel is being installed, install new flywheel mounting dowel pins.

ah. Screw two  $\frac{1}{2}$ -20 by 4- or 5-inch long studs into the crankshaft to use as guides for installing the flywheel. Position the flywheel on the guide studs; insert the six screws (14); tighten them alternately to a torque of 100 to 110 foot-pounds. Remove the two guide studs.

ai. Attach an indicator gage to the side of the flywheel housing as shown in figure 146 to indi-

cate the flywheel bore runout. Rotate the flywheel and take readings at various points on the circumference. The total runout must not be greater than 0.004 inch. Shift the gage to indicate the face of the flywheel as shown in figure 147; mark four equidistant points and rotate the crankshaft to take readings at each one. Take up the crankshaft end play before taking the readings. The face runout should not exceed 0.005 inch. If the runout of the bore or face of the flywheel is not within the above tolerance, remove the flywheel and check the crankshaft flange and flywheel for dirt or burs on the mating surfaces. Remove the dowels and ream to the nearest oversize if required.

*aj.* When flywheel bore and face gage readings are within tolerance, lock the screws in pairs with the lockwire (15, fig. 114).

*ak.* Turn the engine and support it so the cylinder head side will be up.

*al.* Install the tappets into their respective positions so that the guide slots are alined with the guide openings. The injector tappets are larger and are placed between the exhaust and the intake tappets. Install the tappet guides (1, fig. 113) on the side of the cylinder block.

*am.* Position the cylinder head gasket (20, fig. 134) on the cylinder block; install the

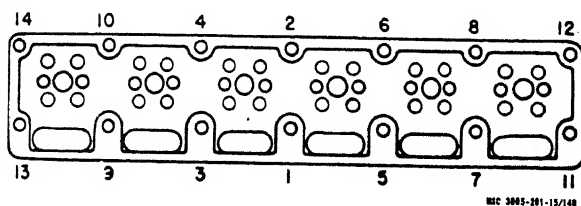


Figure 149. Tightening sequence for cylinder head screws.

grommets (21, 22, and 24) and the push tube opening rings (23) as shown in figure 148.

*an.* Lower the cylinder head into position over the gasket and the dowels.

*ao.* Install the six injector push rods (8, fig. 113) and the 12 intake and exhaust valve push rods (7) into the proper tappets.

*ap.* Position the injectors in their respective positions on the cylinder head; secure each with two screws. Tighten to a torque of 10 to 12 foot-pounds.

*aq.* Use a bar or wooden slat as shown in figure 112 to keep the rocker levers alined; position the rocker lever assembly on the cylinder head. Back off all of the rocker lever adjusting screws. If necessary, drive the assembly down over the mounting dowels with light blows of a soft hammer. Install the rocker lever bearing screws (4, fig. 129) and tighten securely.

*ar.* Lubricate the cylinder head screws (27 and 28, fig. 111) with clean lubricating oil; install the screws and the washers (29) and tighten to a torque of 25 foot-pounds in the sequence shown in figure 149. Check all of the rocker levers to be sure that they are free. Continue to tighten in sequence in 100-foot-pound increments to 300 foot-pounds; tighten in sequence in 50-foot-pound increments to 400 foot-pounds. After the cylinder head has been tightened, check the rocker levers to make sure they are not binding.

*as.* Adjust the injectors as directed in paragraph 134; adjust the valves as directed in paragraph 165.

*at.* Install the cylinder head cover as directed in subparagraph 164c.

*au.* Install the fuel supply and drain manifolds as directed in subparagraph 132c.

*av.* Install the exhaust manifold as directed in subparagraph 166c; install the intake manifold as directed in subparagraph 167c.

### Section III. FUEL SYSTEM

#### 237. Injectors

*a. General.* A description of the fuel injectors is given in the organizational maintenance section of this manual. Refer to paragraph 134.

*b. Removal and Disassembly.*

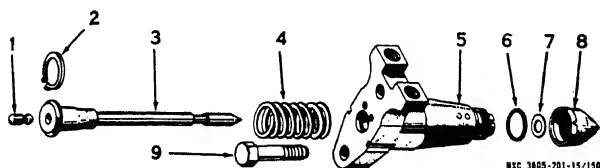
(1) Remove the injectors from the engine as directed in paragraph 227i.

(2) Lift the injector plunger (3, fig. 150)

and the plunger spring (4) from the injector body (5); tag the mating parts so that they will be returned to their respective places when reassembled.

(3) Mount the injector on a holding fixture as shown in figure 151.

**Caution:** Never clamp the injector body in a vise; this may distort



- |                    |                       |
|--------------------|-----------------------|
| 1 Plunger link     | 6 Preformed packing   |
| 2 Retaining ring   | 7 Injector cup gasket |
| 3 Injector plunger | 8 Injector cup        |
| 4 Plunger spring   | 9 Screw               |
| 5 Injector body    |                       |

Figure 150. Injector assembly, exploded view.

the body and result in a stuck injector plunger.

- (4) Use a splined wrench adapter, as shown in figure 152, and a 1 $\frac{1}{4}$ -inch socket wrench to remove the injector cup (8, fig. 150) from the injector body; remove the injector cup, the injector cup gasket (7), and the preformed packing (6) from the injector body.
- (5) If the injector plunger link (1) requires replacement, remove the link.

#### c. Cleaning and Inspection.

- (1) Thoroughly clean any carbon or varnish from the injectors by soaking in

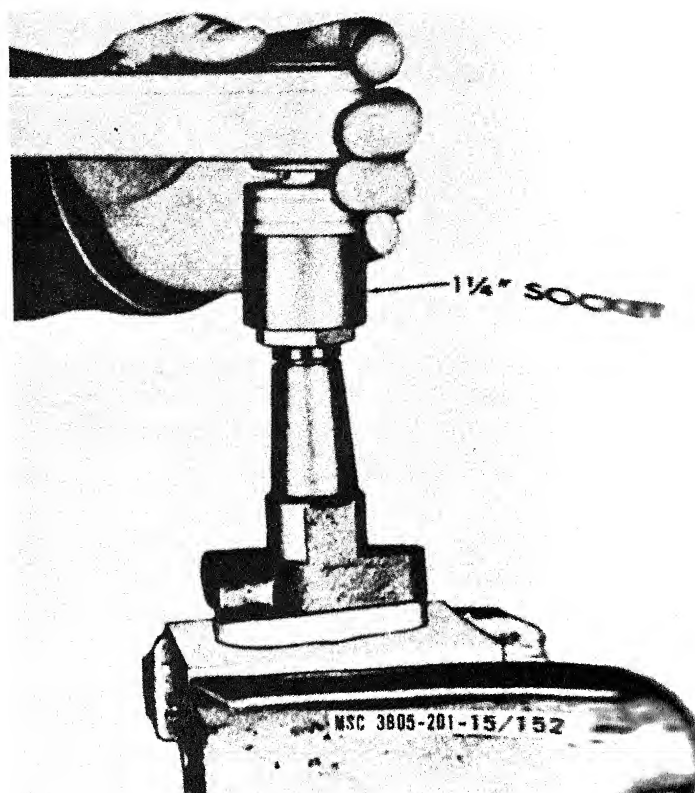


Figure 152. Removing injector cup.

an approved cleaning solvent. Neutralize the solvent after cleaning by dipping the injectors in mineral spirits. Dry with clean, dry compressed air.

- (2) Use a magnifying glass to inspect the injector cup tip for signs of wear. A new injector cup tip is shown in figure 153; a worn injector cup tip is shown in figure 154. This type of wear, which can begin internally, causes a faulty spray pattern. Faulty spray holes can be caused by the use of drills, wires, or other instruments when cleaning the injectors. The effect of high acid or sulphur content in the fuel and excessive heat caused by an overload condition is shown in figure 155; the metal has been eaten away at "A".
- (3) Inspect the injector body plunger bore and the injector plunger for wear or scoring. Use a strong magnifying glass to check for burrs or distorted radii in the injector body orifices. When the orifices are damaged, the in-

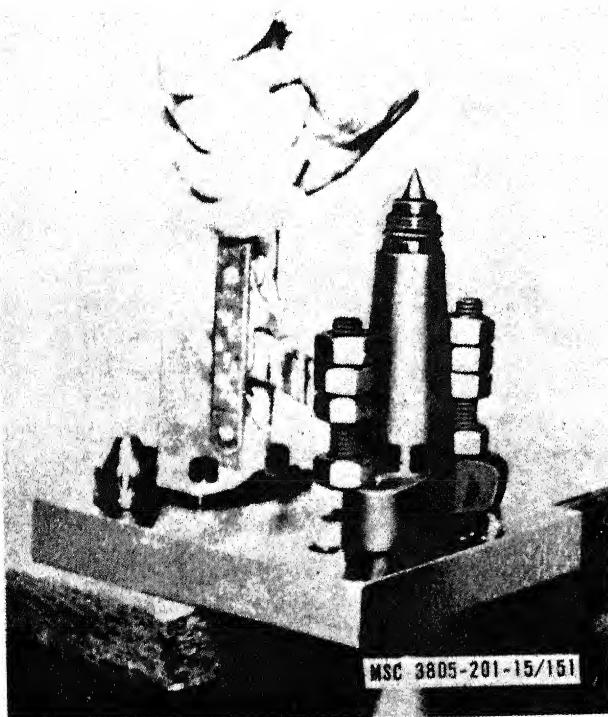


Figure 151. Injector in holding fixture.

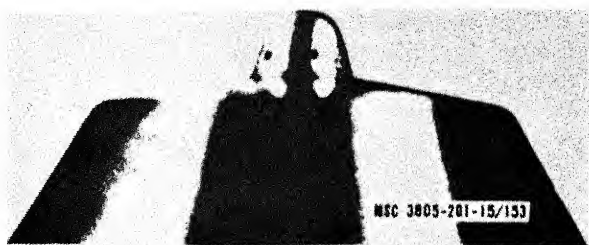


Figure 153. New injector cup tip.

jector will not function properly. If defective, replace both the injector body and plunger as an assembly.

- (4) Inspect the plunger spring for cracking or distortion.
- (5) If the connection seal surface of the injector body is rough, use a spot-facing tool as shown in figure 156 to face the surface.
- (6) Replace the preformed packing and gasket each time the injector cup is removed.

*d. Reassembly and Installation.*

- (1) Use an assembly tool as shown in figure 157 to install a new preformed packing (6, fig. 150) on the injector body (5); dip the preformed packing in lubricating oil before sliding it over the assembly tool onto the injector body.
- (2) The proper size injector cup gasket (7) is determined by the size markings stamped on the injector body (fig. 158). The gasket should have the same number of notches as there are letters after the number; an injector marked 3S would use a gasket with one notch; an injector marked 1SS would use a gasket with two notches. Coat the



Figure 154. Worn injector cup tip.

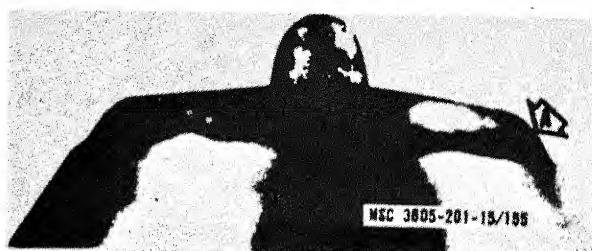


Figure 155. Corroded injector cup tip.

proper gasket with grease and position it on the injector body.

- (3) Mount the injector on a holding fixture as shown in figure 151. Use a splined wrench adapter, as shown in figure 152, and a torque wrench with a 1 1/4-inch socket to install the injector cup (8, fig. 150) on the injector body. Tighten the injector cup to a torque of 60 foot-pounds. Overtightening will distort the cup and prevent the injector plunger from seating properly. Undertightening may cause the engine to miss.
- (4) If the injector plunger link (1) has been removed, position the link on the injector plunger (3).
- (5) Position the injector plunger spring (4) on the injector body. Coat the injector plungers with lubricating oil and install in the injector body. Be

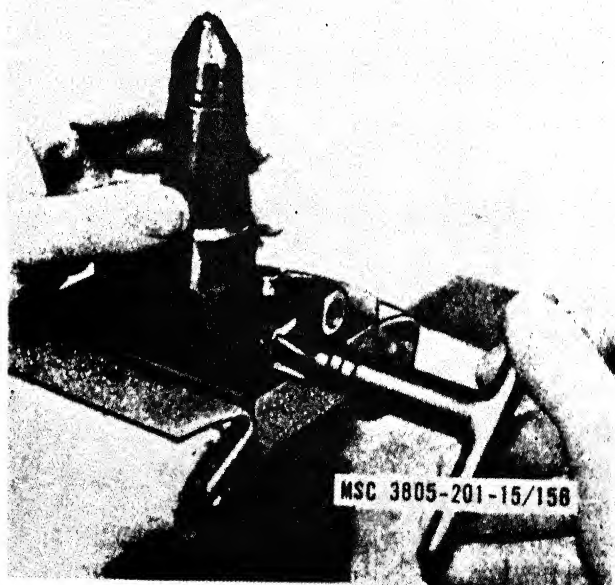


Figure 156. Resurfacing connection seal surfaces.

sure that the plungers are returned to their respective injector bodies or proper operation will not be obtained.

- (6) Test the injector as directed in *e* below.
- (7) Install the injector as directed in paragraph 236*ar*.

*e. Testing.*

- (1) Check the injector cup spray hole openings by filling the injector body two-thirds full of clean fuel oil; insert the plunger and force the fuel out of the spray holes. Observe the spray pattern.
- (2) Check the injector plunger seat as follows:
  - (a) Position the assembled injector on a seat checking tool, as shown in figure 159. The tool requires an air pressure supply of 80 to 90 psi.
  - (b) Fill the inlet and the drain connection holes with fuel oil.
  - (c) Press the plunger into the seat with the pivot handle.
  - (d) Press the button to release the air pressure. If the plunger and cup are not sealing properly, bubbles will appear at the inlet and drain holes.
  - (e) If leakage is indicated, remove the plunger and check for dirt. After carefully cleaning the plunger, reassemble to the injector body and repeat the above test. If leakage is still present, remove the injector cup as directed in *b*(4) above.

### 238. Fuel Pump

*a. General.* The gear pump section of the fuel pump draws fuel from the fuel tank and delivers it, under pressure, to the injector supply manifold under control of the governing and metering sections of the fuel pump. In this manner, the speed of the engine is controlled by the fuel pump which, in turn, controls the supply of fuel to the engine. The fuel pump is coupled to the air compressor crankshaft, which is driven by the engine gear train. The fuel pump main shaft turns at engine crankshaft speed and drives the gear pump and the fuel pump governor.

*b. Removal and Disassembly.*

- (1) Remove the fuel pump from the engine as directed in paragraph 130*c*. Remove

the fuel shutoff valve as directed in paragraph 239.

- (2) Mount the fuel pump in a convenient holding fixture.

*Note.* Thoroughly clean the exterior of the fuel pump, all tools to be used, and the working area before beginning fuel pump disassembly. Disassemble and overhaul only as far as necessary. Instructions for complete disassembly and parts replacement are given, not because all operations are necessary for overhaul, but to supply instructions as needed.

- (3) Fuel pressure damper (fig. 160).
  - (a) Remove the two screws (41), lock-washers (40), and flat washers (39) that secure the fuel pressure damper to the gear pump; remove the damper. Remove the coupling (42) and seal (30) from the damper.
  - (b) Remove the two screws (31), lock-washers (32), and flat washers (33) that secure the damper housing (34) to the cover plate (38); remove the housing and diaphragm (36).
  - (c) Remove the preformed packings (35 and 37) from the housing and the cover.

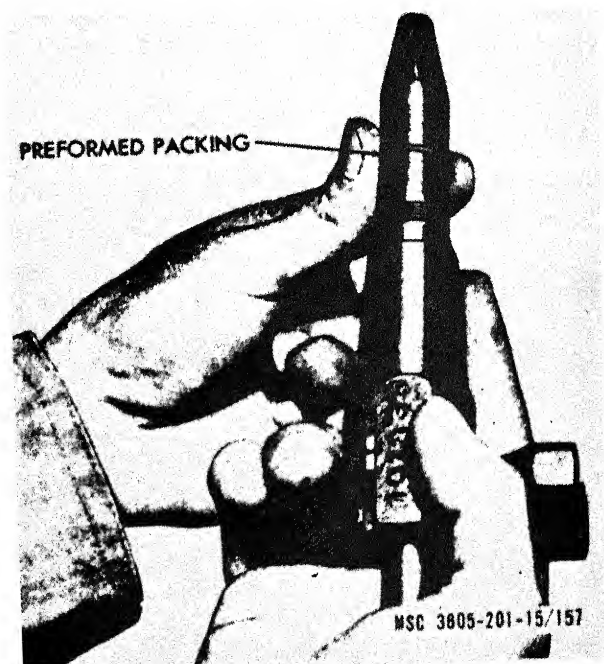


Figure 157. Installing preformed packing.



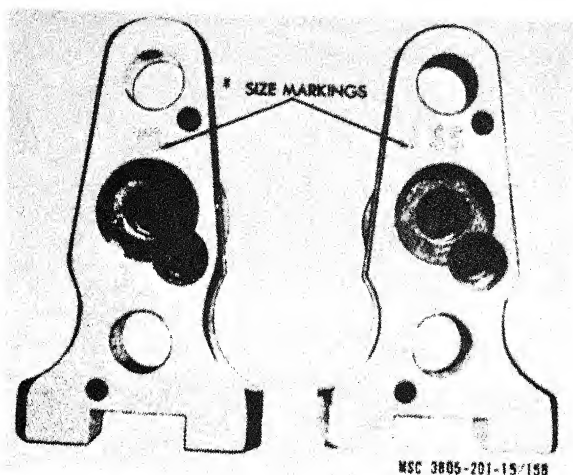


Figure 158. Injector size markings.

- (4) Main shaft, cover, and governor group.
  - (a) Remove the seven capscrews (117 and 123, fig. 160), lockwashers (116 and 124), and flat washers (115 and 125) that secure the cover (114) to the fuel pump housing. Tap the edge of the cover lightly with a plastic hammer to loosen it and remove the assembled cover, main shaft, governor, and gasket (113).
  - (b) If it is necessary to remove the governor carrier assembly (106) and assembled parts, heat the cover in hot water or with a heat lamp to 200° F. Use a puller that engages under the governor drive gear (110) and pull the governor carrier assembly and its bushing (111) from the cover.
  - (c) Remove the retaining ring (112) that secures the bushing to the shaft of the carrier; remove the bushing.
 

*Note.* If the retaining ring (112) pulls from the carrier assembly (106) while removing the shaft, pull the bushing with an internal engaging puller or cut off the bushing shoulder with a 5/8-inch drill and tap, and pull the bushing.
  - (d) Remove the retaining ring (129) that holds the ball bearing (128) in the cover as shown in figure 161. Remove the capscrew (120, fig. 160), lockwasher (119), and flat washer (118) that hold the coupling (121) to the drive shaft (127).
  - (e) Screw a 3/8-24 capscrew into the

threaded end of the drive shaft to prevent damage to the coupling half, and press against the capscrew to remove the drive shaft assembly from the cover. Remove the coupling half and woodruff key (126).

- (f) Press the oil seals (122) from the cover.
  - (g) Press the tachometer drive gear (132) and governor drive gear (131) from the shaft.
  - (h) If the ball bearing (128), or shaft (127) requires replacement, press the ball bearing from the shaft, being careful to support the inner race of the bearing in the press.
  - (i) If the governor drive gear (110) or shaft is damaged, press the gear from the shaft.
  - (j) Except in an emergency; do not remove the governor weights (107) from the weight carrier. The weights, pivot shaft (108), and pivot pins (109) are provided as a tested assembly and should be replaced completely.
- (5) Governor drive plunger (fig. 160).
    - (a) Pull the governor drive plunger (95) and assembled parts from the pump housing (88).
    - (b) Grasp the torque spring (94) at the point at which it engages the plunger and gently twist it from the shaft, being careful not to distort the spring.

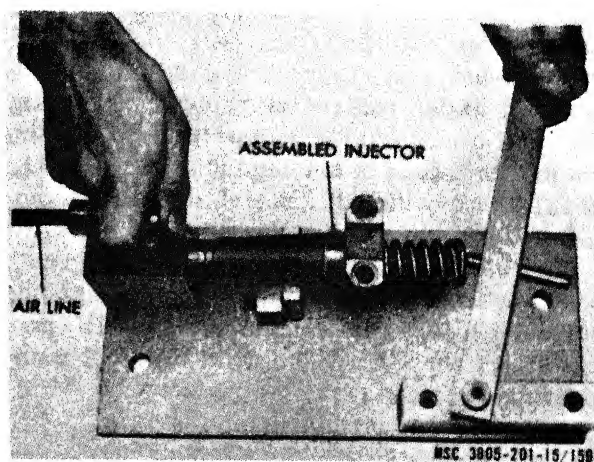
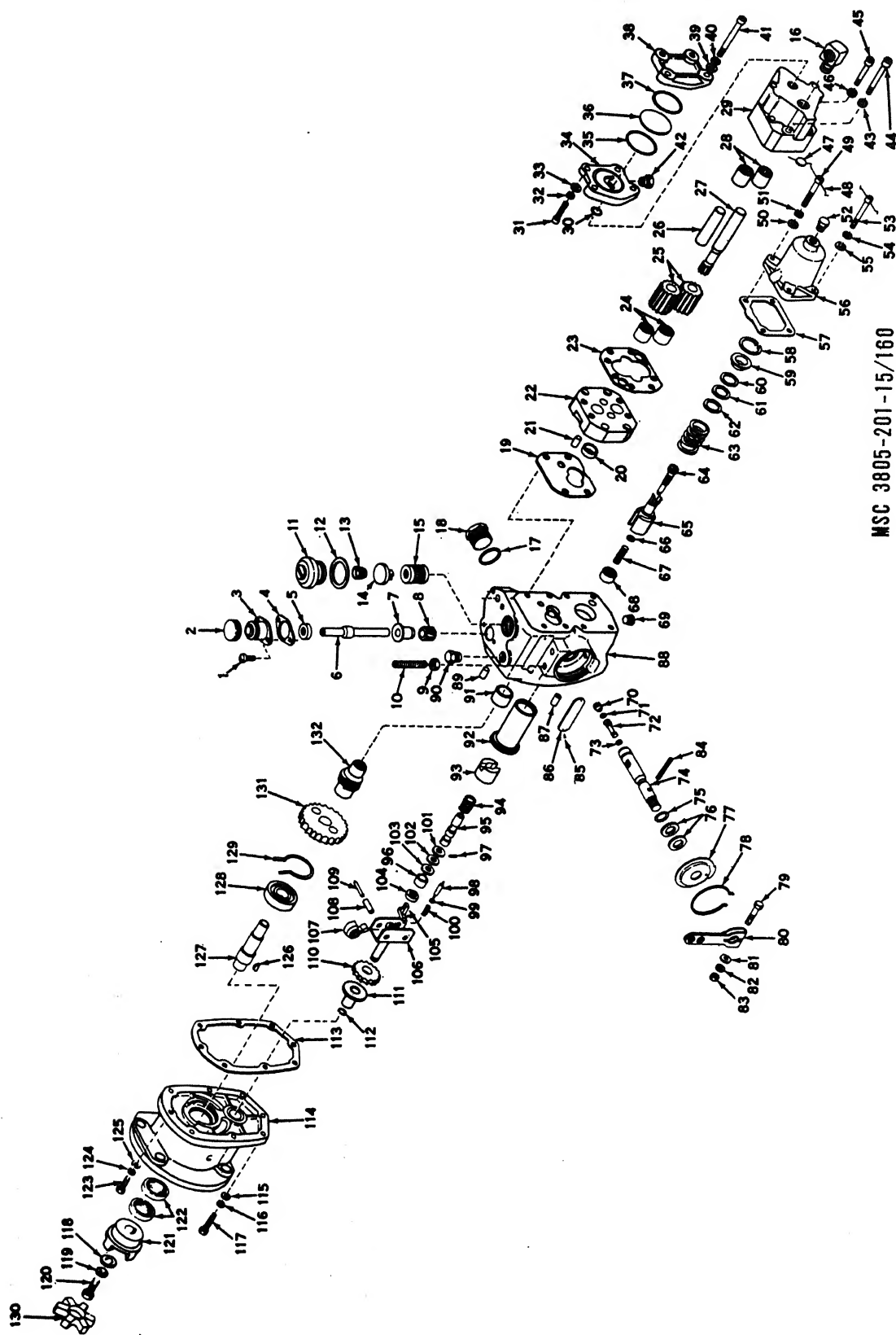


Figure 159. Testing injector plunger seat.

- (c) Rest the governor drive plunger on the copper jaws of a vise and drive out the retaining pin (97) that holds the plunger driver (105) to the plunger; pull the driver and thrust washer (104) from the plunger.
  - (d) If worn or damaged, press the plunger spacer (96) from the plunger.
- (6) Throttle shaft (fig. 160).
- (a) Compress the retaining ring (78) with a pair of pliers and remove it from its groove in the pump housing (88). Pull the throttle shaft (74) and assembled parts from the fuel pump.
  - (b) Remove the screw (79), nut (83), lockwasher (82), and flat washer (81) that hold the throttle lever (80) to the shaft; remove the throttle lever and shaft cover (77).
  - (c) Remove and discard the preformed packing (75).
  - (d) Remove the setscrew (70) and lockwasher (71) that hold the restricting plunger (72) in the throttle shaft; remove the plunger and shims (73).
  - (e) If the throttle shaft (74) or the throttle stop (76) is damaged, drive out the pin (84) and remove the stop from the shaft.
- (7) Gear pump.
- (a) Match-mark the gear pump housing (29, fig. 160) and cover (22) to the fuel pump housing. Remove the four screws (44) and lockwashers (43) that hold the gear pump assembly to the pump housing. Tap the sides of the gear pump lightly with a plastic hammer to loosen the pump from the ring dowel (20); pull the pump from the housing.
  - (b) Remove the four screws (45) and lockwashers (46) that hold the cover (22) to the housing (29). Start the two long capscrews in the cover and drive against the capscrew heads to separate the parts (fig. 162); remove the gasket (23, fig. 160).
  - (c) Remove the assembled shafts (26 and 27) and gears (25).
- (8) Governor spring pack (fig. 160).
- (a) Remove the seal (47) and lockwire (48) from the governor spring pack mounting screws (49 and 53). Remove the four screws, lockwashers (51 and 54), and flat washers (50 and 55) that secure the spring pack cover (56) to the pump housing; remove the spring pack cover and gasket (57).
  - (b) Remove the retaining ring (58) from its groove in the spring pack housing (92) to release the spring retainer (59), shims (60 through 62), and governor spring. Remove the assembled idle adjusting screw (64) and guide (65), and the spring rest washer (66), idle spring (67), and idle spring plunger (68).
- (9) Fuel filter screen (fig. 160).
- (a) Remove the filter cap (11) and seal (12) from the pump housing (88). Remove the spring (13) and filter screen assembly.
  - (b) Remove the magnet (14) from the screen (15). Check the magnet for metal chips that may indicate pump trouble.
- (10) Tachometer drive assembly.
- (a) Remove the dust cap (2, fig. 160) from the tachometer drive assembly (3). Remove the two machine screws (1) that hold the tachometer drive assembly to the pump housing; remove the tachometer drive assembly and gasket (4).
  - (b) Using a brass punch and hammer, carefully drive the assembled tachometer drive shaft (6), seal (5), bushing (7), and drive gear (8) from the housing, as shown in figure 163. Remove the seal.
  - (c) If any parts are worn or damaged, press the shaft from the gear and bushing.
- c. *Cleaning, Inspection, and Repair.*
- (1) Clean all parts in an agitated solvent tank with a solvent that will not damage aluminum. Dry the parts thoroughly. Lubricate the bearings with light oil.





MSC 3805-201-15/160

Figure 160. Fuel pump, exploded view.

1 Screw	35 Preformed packing	70 Setscrew	103 Shim
2 Dust cap	36 Diaphragm	71 Lockwasher	104 Thrust washer
3 Tachometer drive housing	37 Preformed packing	72 Restricting plunger	105 Governor plunger driver
4 Gasket	38 Cover plate	73 Adjusting shim	106 Carrier assembly
5 Drive shaft seal	39 Flat washer	74 Throttle shaft	107 Governor weight assembly
6 Drive shaft	40 Lockwasher	75 Preformed packing	108 Weight pivot shaft
7 Bushing	41 Screw	76 Throttle stop	109 Weight pivot pin
8 Drive gear	42 Coupling	77 Shaft cover	110 Governor drive gear
9 Adjusting nut	43 Lockwasher	78 Retaining ring	111 Bushing
10 Setscrew	44 Screw	79 Screw	112 Retaining ring
11 Filter cap	45 Screw	80 Throttle lever	113 Gasket
12 Seal	46 Lockwasher	81 Flat washer	114 Bearing and seal cover
13 Spring	47 Seal	82 Lockwasher	115 Flat washer
14 Magnet	48 Lockwire	83 Nut	116 Lockwasher
15 Screen	49 Screw	84 Pin	117 Capscrew
16 Elbow	50 Flat washer	85 Drive screw	118 Flat washer
17 Preformed packing	51 Lockwasher	86 Nameplate	119 Lockwasher
18 Plug	52 Plug	87 Dowel	120 Capscrew
19 Gasket	53 Screw	88 Pump housing	121 Coupling
20 Ring dowel	54 Lockwasher	89 Dowel	122 Seal
21 Dowel	55 Flat washer	90 Plug	123 Capscrew
22 Cover	56 Spring pack cover	91 Bushing	124 Lockwasher
23 Gasket	57 Gasket	92 Spring pack housing	125 Flat washer
24 Needle bearing	58 Retaining ring	93 Sleeve	126 Woodruff key
25 Gear	59 Spring retainer	94 Spring	127 Drive shaft
26 Driven gear shaft	60 Shim	95 Governor drive plunger	128 Ball bearing
27 Drive gear shaft	61 Shim	96 Plunger spacer	129 Retaining ring
28 Needle bearing	62 Shim	97 Spring retaining pin	130 Spider
29 Housing	63 Governor spring	98 Assist plunger	131 Governor drive gear
30 Seal	64 Idle adjusting screw	99 Washer	132 Tachometer drive gear
31 Screw	65 Guide	100 Spring	
32 Lockwasher	66 Washer	101 Shim	
33 Flat washer	67 Spring	102 Shim	
34 Damper housing	68 Idle spring plunger		
	69 Plug		

Figure 160—Continued.

(2) Check the front drive shaft bushing (91, fig. 160) in the pump housing with an inside bore gage as shown in figure 164. Check in both a horizontal and vertical direction. If the bushing is worn to more than 0.7525 inch, use a gouge chisel to cut the worn bushing and remove it from the housing. Ap-

ply a thin coat of lubriplate or equivalent high-pressure grease on a new bushing and press it into place in the housing. Line-ream the bushing with a 0.750-inch reamer to 0.7495 to 0.7505 inch as shown in figure 165.

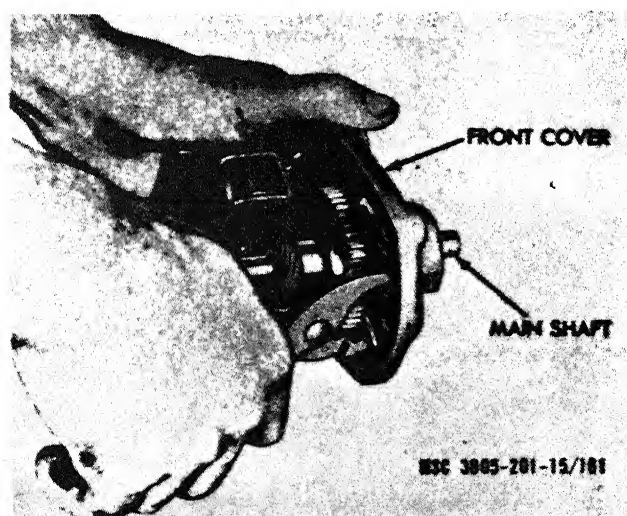


Figure 161. Removing retaining ring from cover.

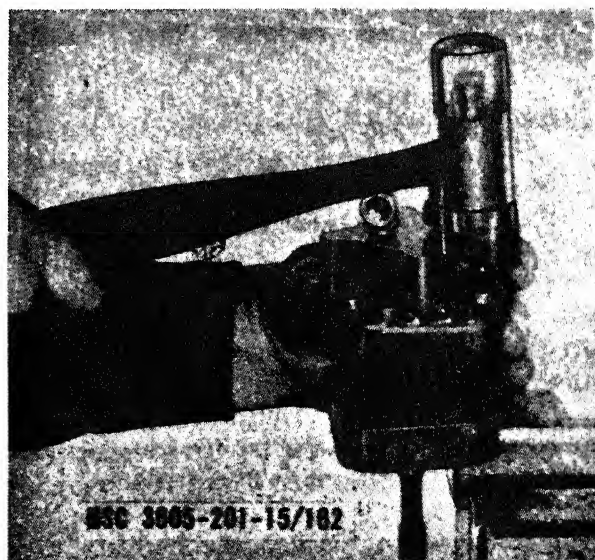


Figure 162. Separating gear pump housing and cover of fuel pump.

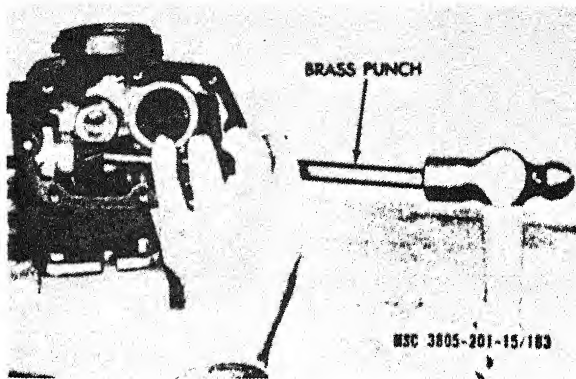


Figure 163. Driving tachometer drive shaft from housing.

- (3) Check the fit of the throttle shaft (74, fig. 160) in the sleeve of the pump housing. If the sleeve is worn, replace the shaft with one having a higher class number. Lap in place to relieve the binding. Use only a fine lapping compound. Clean all lapping compound from the parts when proper fit is attained.

*Note.* If the throttle shaft sleeve is worn too large to accommodate a Class 5 shaft, replace the housing.

- (4) Check the gear pump shafts (26 and 27) for scoring at the bearing surfaces. If any scoring or roughness is apparent, replace the shaft. Check the gear pump gears (25) for scoring or damage. Check the gear lengths with a micrometer. If worn to less than 0.7483 inch, press the gears from the shafts and replace. When pressing the gears onto the shafts, grind a nut or a piece of tubing to 0.690-inch length and use it to limit the distance the gears can be pressed onto the shaft. Before pressing, heat the gears to 200° F. and coat the shaft with lubriplate to prevent bending the shaft.
- (5) Check the fit of the gears in the gear pockets. The gears should be at least flush with the gasket surface of the lever, but should not extend more than 0.0007 inch above the gasket surface.
- (6) Insert the shafts into the needle bearings, as shown in figure 166, one at a time, and rotate the shaft to check for roughness. Watch the needles; they should rotate freely. If the needle bearings are worn or damaged, press

the bearings out of the cover with an arbor press. To remove the bearings from the gear pump housing (29, fig. 160), use a puller as shown in figure 167. Coat new needle bearings with a light coat of lubriplate or an equivalent high-pressure grease and press into place, being careful to support the inner race. Press against the end that has the identification numbers or letters.

- (7) Check the gear pump housing (29, fig. 160) and cover (22) for cracks, wear, or scoring; replace any damaged parts.
- (8) Check the rotation of the drive shaft ball bearing (128). If it operates roughly or with difficulty, press the bearing from the shaft and press a new bearing in place, being careful to support the inner race of the bearing.
- (9) Check the gears (8, 110, 131, and 132) for cracks, chipped teeth, wear, out-of-round bores, or other damage; replace damaged gears.
- (10) Inspect the screen (15) for distortion, holes, clogging, or other damage; replace a damaged screen.
- (11) Inspect all springs (13, 63, 67, and 94) for distortion or damage; replace any damaged springs.



Figure 164. Checking fuel pump drive shaft bushing for wear.

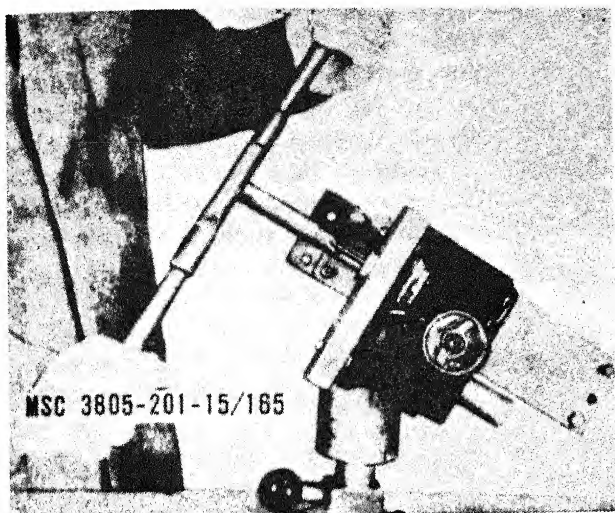


Figure 165. Line-reaming fuel pump drive shaft bushing.

- (12) Inspect all other parts for cracks, scoring, distortion, or other damage that could reduce their effectiveness; replace damaged parts.

*d. Reassembly and Installation.*

*Note.* All working parts must be dipped or coated with light oil during assembly. Apply a light coat of lubriplate to all parts that must be pressed into place in the aluminum castings; this will prevent metal seizure and distortion of the bores.

- (1) Tachometer drive assembly (fig. 160).
  - (a) Position the bushing (7) on the tachometer drive shaft (6) so that the chamfered end of the bushing faces the gear end of the shaft. Press the drive gear (8) onto the shaft until it is flush with the end of the shaft. Make sure the shaft turns freely in the bushings.
  - (b) Position the assembled tachometer drive shaft into its port in the pump housing (88) and use a 1/2-inch-deep socket as a mandrel to drive the shaft assembly into the pump housing.
  - (c) Again using a deep 1/2-inch socket, drive the oil seal (5) into place on the tachometer shaft.
  - (d) Position the tachometer drive housing (3) and gasket (4) on the pump housing; secure with two machine screws (1). Install the dust cap (2) on the housing.

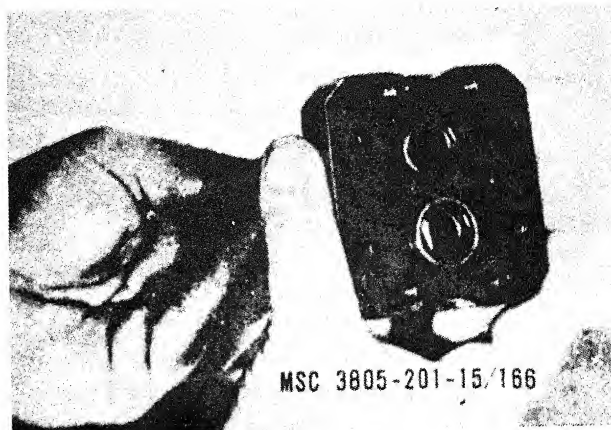


Figure 166. Checking fuel pump needle bearing operation.

- (2) Fuel filter screen (fig. 160).
  - (a) Position the magnet (14) on the fuel filter screen (15); position the parts in the screen port in the pump housing.
  - (b) Position the spring (13) on the magnet; install the filter cap (11) and seal (12) to retain the screen parts. Tighten the cap to 25 to 30 foot-pounds, using a torque wrench.
- (3) Governor spring pack (fig. 160).
  - (a) Turn the idle adjusting screw (64) into its guide (65). Install the washer (66) over the tapered end of the adjusting screw and install the idling spring (67) and idle spring plunger (68). Make sure the spring

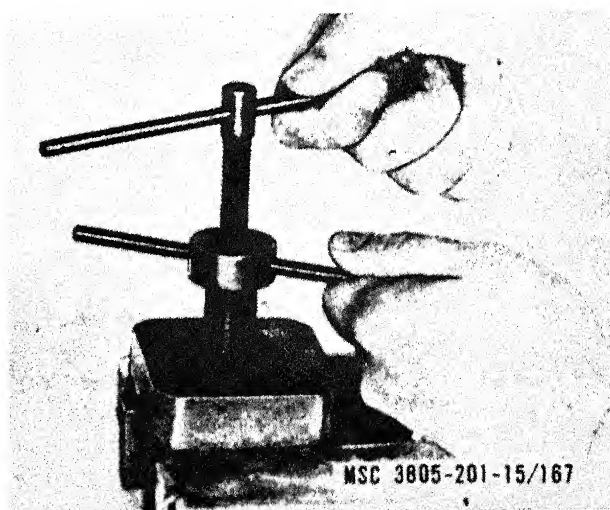


Figure 167. Pulling needle bearing from fuel pump housing.

- enters the deep counterbore of the plunger.
- (b) Slide the assembled plunger, spring, and guide into the spring pack housing (92) in the pump housing. Install the spring (63), shims (62, 61, and 60), and spring retainer (59) in the shim pack housing. Compress the spring (63) enough to install the retaining ring (58) to retain the parts.
  - (c) Position the gasket (57) and spring pack cover (56) on the pump housing; secure with the four screws (49 and 53), lockwashers (51 and 54), and flat washers (50 and 55). Do not install the lockwire (48) and seal (47) until after the pump is calibrated.
  - (d) Make sure the plug (52) is installed in the spring cover.
- (4) Gear pump (fig. 160).
- (a) Install the assembled gears (25) and shafts (26 and 27) in the gear pump housing (29). Position a new gasket (23) and the cover (22) on the housing; secure with the four screws (45) and lockwashers (46). Tighten the screws to 17 foot-pounds. After tightening, the shafts must turn freely with finger pressure. A properly assembled pump will have end play of approximately 0.002 inch. If the pump binds, disassemble and correct the cause of the binding before installing it.
  - (b) Position the pump on the fuel pump housing; secure with the four screws (44) and lockwashers (43). Tighten the screws to a torque of 9 foot-pounds.
- (5) Throttle shaft (fig. 160).
- (a) If the throttle stop (76) was removed, position it on the throttle shaft; secure by driving in the pin (84).
  - (b) Position a tapered mandrel over the end of the throttle shaft and coat the mandrel and a new preformed packing (75) with grease. Slide the preformed packing over the mandrel into position on the throttle shaft.
  - (c) Install the shims (73) and restricting plunger (72) in the counterbore in the throttle shaft. Add enough shims so that the fuel passage in the throttle shaft is completely open. The shim thickness will be properly adjusted during final testing. Secure the parts by installing the lockwasher (71) and setscrew (70).
  - (d) Position the shaft cover (77) and throttle lever (80) on the throttle shaft; secure by installing the screw (79), lockwasher (82), flat washer (81), and nut (83).
  - (e) Install the assembled throttle shaft in the pump housing; secure with the retaining ring (78).
- (6) Governor plunger.
- (a) If the plunger spacer (96, fig. 160) was removed, press it into the governor drive plunger (95). Install the thrust washer (104) on the governor drive plunger (95). The chamfered side of the thrust washer must be installed toward the plunger driver (105). Drive the plunger driver into place in the governor drive plunger (95) so that there is a clearance of 0.002 to 0.005 inch between the driver and the washer face when measured as shown in figure 168. Make sure the thrust washer is free on the assembly.
  - (b) Drive the spring retaining pin (97, fig. 160) through the plunger and plunger driver. Protect the finish of the plunger by resting it on the copper jaws of a vise while driving the pin.
  - (c) Install the shims (101 through 103) and torque spring (94) on the governor drive plunger. Put the small end of the spring on the shoulder end of the plunger with a twisting motion to prevent distortion of the spring. Install the governor drive plunger in the pump housing.
- (7) Main shaft, cover, and governor group (fig. 160).
- (a) Press the governor drive gear (110) on the shaft of the carrier assembly. Take care not to press against the governor weights since this may



bend the weight pins and upset the governor operation.

- (b) Slip the governor carrier bushing (111) on the shaft of the carrier assembly; secure with a retaining ring (112).
- (c) If removed, press the ball bearing (128) onto the drive shaft (127). Use a piece of tubing or a wrench socket so that the force of the press is exerted against the inner race of the bearing.
- (d) Coat the drive shaft with lubriplate and press the governor drive gear (131) onto the shaft against the drive shaft bearing.
- (e) Press the tachometer drive gear (132) onto the shaft against the governor drive gear. Check that all parts are firmly seated on the shaft.
- (f) Install the retaining ring (129) between the ball bearing and governor drive gear.
- (g) Press the oil seals (122) into the bearing and seal cover (114) from opposite ends of the cover. The lips of the seal should face each other.
- (h) Position a special oil seal tool over the end of the main shaft and coat the tool with grease. Press the main shaft assembly into the front cover through the seals; secure by firmly seating the retaining ring (129) into the grooves in the bearing and seal cover.
- (i) Position the drive coupling (121) on the end of the drive shaft and support the drive shaft assembly on the governor drive gear. Press the coupling onto the shaft. Secure with a cap screw (120), lockwasher (119), and flat washer (118). Hold the governor drive gear in a copper-jawed vise while tightening the screw.
- (j) Heat the front cover with a heat lamp to approximately 200°F. Coat the governor carrier bushing (111) with lubriplate and press the governor assembly into the cover. Use a wrench socket to press on the carrier instead of the weights. Take care to mesh the gears to avoid

damage to the gear teeth. Make sure the bushing shoulder seats squarely against the cover.

- (k) Install the spring (100), washer (99), and governor assist plunger (98) into the bore of the carrier assembly shaft. Install enough shims in back of the spring to make the governor assist plunger protrude between 0.860 and 0.880 inch above the gasket face of the front cover. Use a depth micrometer to gage the correct protrusion. Subtract the carrier assembly-to-plunger measurement from the carrier assembly-to-housing face measurement to ascertain the correct dimension.
  - (l) Place the pump in a vertical position with the bearing and seal cover face up. Position the gasket (113) on the face of the housing. Turn the governor plunger driver to a 3-o'clock-9-o'clock position. Make sure the governor assist plunger is in the bore of the carrier assembly shaft. Hold the governor weights in to retain the governor assist plunger.
  - (m) Position the assembled bearing and seal cover (114) on the pump housing so that the tachometer gears mesh properly and the governor plunger driver engages the governor between the weights. Secure the cover assembly with the seven cap screws (117 and 123), lockwashers (116 and 124), and flat washers (115 and 125).
- (8) Fuel pressure damper (fig. 160).
- (a) Coat new preformed packings (35 and 37) with grease and position the preformed packings in the damper housing (34) and the cover plate (38). Position the diaphragm (36) on one of the preformed packings.
  - (b) Position the cover plate on the damper housing; secure with two screws (31), lockwashers (32), and flat washers (33).
  - (c) Install the coupling (42) in the port at the bottom of the damper housing.
  - (d) Position the seal (30) in the seat in the back of the damper housing.

Position the damper housing on the gear pump so that the seal engages the port on the gear pump housing. Secure the damper to the gear pump with the two screws (41), lockwashers (40), and flat washers (39).

(9) Installation and testing.

(a) Test and calibrate the fuel pump as directed in *e* below.

(b) Install the fuel pump as directed in paragraph 130*e*.

*e. Testing and Calibration* (fig. 160).

(1) *Fuel pump hookup.*

(a) Install the proper drive coupling on the drive shaft of a typical fuel pump test stand.

(b) Mount the fuel pump on the mounting bracket and adjust the test stand coupling to obtain proper alignment with the fuel pump.

(c) Squirt a few drops of clean lubricating oil into the gear pump inlet hole; connect the fuel suction line. An adequate supply of injector oil, at a minimum of 80°F., must be provided.

(d) Connect the gear pump pressure line to the back of the fuel pump at the pipe plug hole, just ahead of the governor barrel. Make sure the fuel damper housing described in *d*(8) above is in place during the test.

(e) The restricting plunger (72) in the

throttle shaft was shimmed as described in *d*(5) (*c*) above to provide a wide open throttle port. If this was not done during overhaul, or if the pump is being tested without overhaul, check to assure that the requirement is met.

(f) Remove the plug (90) from the top of the fuel pump. Fill the pump with clean test oil and reinstall the plug.

(g) Install a line from the fuel shutoff valve outlet connection to an orifice block that contains a manifold orifice which allows a flow of 579 to 581 pounds per hour of test oil at 90 psi constant pressure with 80°F. minimum temperature, and an idle orifice which allows a flow of 56.5 to 57.5 pounds per hour of test oil at 90 psi constant pressure with 80°F. minimum temperature. Provide valves for selecting the proper orifice and a pressure gage to indicate the pressure.

(h) Manually open the fuel shutoff valve by turning the over-ride knob; open the manifold orifice valve. Move the throttle control lever to the wide open position; start the fuel pump drive; and run the fuel pump at 500 rpm until the manifold pressure gage shows steady pressure. If the pump does not produce a pressure indication after a couple of minutes of operation, check for closed valves in the suction line or for air leaks.

(i) Gradually increase the fuel pump speed to 1,500 rpm and operate for 5 to 10 minutes to make sure the pump runs freely without overheating. After 5 or 6 minutes, observe the fuel flow in the graduate and check the orifice block sight gage for air bubbles before starting calibration. If air is present, correct the leak before continuing the test.

(j) With the manifold orifice of the test stand open and the idle orifice closed, open the throttle to the full-fuel position. Increase the pump speed until maximum fuel manifold pressure is indicated; then reduce the speed



Figure 168. Checking fuel pump plunger driver clearance.



to 100 rpm below rated speed. Back off the rear throttle setscrew (10) just enough to obtain maximum fuel pressure. Lock the adjustment.

(2) *Fuel pump suction test.*

- (a) Operate the pump at 500 rpm and close the valve in the pump suction line. Read the vacuum gage. It should indicate a minimum of 28 inches of mercury. If the reading is less than this, check for an air leak in the suction line. If there is none, the gear pump is faulty.
- (b) Increase the pump speed until the fuel pressure is near maximum. Adjust the suction valve until the vacuum gage shows 8 inches of mercury.

(3) *Governor speed adjustment.*

- (a) Increase the engine speed until the manifold pressure gage drops to 40 psi. The pump should be governed for 2100 rpm. At this point in the test procedure, the pump speed as indicated on the test stand tachometer should be 2160 to 2200 rpm.
- (b) If the speed is lower than 2160 rpm, remove the spring pack cover (56) and add shims (60-62) between the high speed governor spring (63) and its retainer (59). Each shim is 0.001 inch thick, and will vary the output speed by approximately 2 rpm.

*Note.* Each time the spring pack cover is removed to adjust shim thickness, the pump will drain and it will be necessary to refill the pump as described in (1)(f) above. Run the pump long enough to get rid of all entrained air before taking additional readings.

- (c) Recheck the adjustment and add shims as necessary to provide a tachometer reading of 2,160 to 2,200 rpm.
- (4) *Speed at peak-pressure check.*
- (a) Increase the fuel pump speed gradually until maximum fuel pressure is indicated. Maximum fuel pressure should occur between 2,040 and 2,060 rpm for a pump governed to 2,100 rpm.
  - (b) If the peak pressure does not occur within this speed range, recheck for

an incorrect adjustment made in (2) above.

(5) *Calibration pressure adjustment.*

- (a) Reduce the pump speed to 2,200 rpm. The pressure output should be between 144 and 147 psi, or 1 to 3 psi lower than peak pressure noted in (3) above.
- (b) If the calibration pressure is not within the required range, remove the spring pack and change the idle spring plunger (68). Plungers are marked with a code number. Plungers with a larger code number decrease pressure. Plungers with a smaller number increase pressure. The No. 47 plunger normally is used with this pump.
- (c) If it is necessary to change plungers, recheck the governed speed and peak pressures as described above.

(6) *Check point pressure comparison.*

- (a) Maintain the valves and throttle in the same position as in (4) above. Operate the pump at 1,600 rpm. The fuel pump output pressure should drop to 105 plus or minus 3 psi.
- (b) If the pressure indication is not within the required range, it indicates the use of an incorrect torque spring (94), an improperly seated spring, or incorrect thickness of shims (101-103). Make the required corrections and recheck the pressure at 1,600 rpm.

(7) *Fuel pressure adjustment.*

- (a) The final adjust fuel pressure at 2,000 rpm should be 112 psi, which is approximately 35 psi less than the maximum calibration pressure obtained in (5) above. This decrease is made by restricting the throttle fuel port and reducing the throttle travel.
- (b) To restrict the throttle fuel port, stop the test stand and remove the throttle shaft (74) from the pump. Remove the shims (73) from the restriction adjusting plunger until the pressure is reduced to between 114 and 117 psi at 2,000 rpm.

**Caution:** Make sure the manifold orifice valve of the test stand is open and the idle orifice closed for this test. Be sure all air is purged from the pump before the final pressure reading is accepted.

- (c) Without changing the valve settings or pump speed, reduce the throttle setting through the remaining 2 to 5 psi by adjusting the setting of the rear throttle setscrew (10). Recheck the adjusted fuel pressure to make sure that the pressure at 2,000 rpm is 112 psi.
- (8) *Throttle leakage adjustment.*
  - (a) Disconnect the fuel output line and check the pump output with the pump operating at 2,000 rpm and the throttle lever blocked all the way toward the gear pump side of the unit. Collect the fuel in a glass graduate for exactly 1 minute. During this interval, the volume of discharge should be exactly 15 cc.
  - (b) If the output volume is not correct, adjust the front throttle adjusting setscrew until the correct reading is obtained. Open and close the throttle several times and recheck the output.
- (9) *Idle speed adjustment.*
  - (a) Reduce the fuel pump operation to minimum speed. Reconnect the output line. Open the idle orifice and close the fuel manifold orifice on the fuel pump test stand.
  - (b) Block the throttle lever (80) in the idle position; increase the fuel pump operating speed to 500 rpm. Check the manifold pressure; it should be 20 psi.
  - (c) If the idle pressure is too low, remove the pipe plug (52) from the end of the spring pack cover (56). Insert a thin-bladed screwdriver into the port and turn the idle adjusting screw (64). Clockwise movement raises fuel pressure; counter-clockwise movement lowers fuel pressure. Refill the pump and run it long enough to expel all air before rechecking the idle adjustment.
- (10) *Pressure at 500 rpm adjustment.*

- (a) Open the valve in the fuel pump suction line all of the way. Close the test stand orifice valves and block the throttle in the wide open position. Fuel pressure indicated by the manifold pressure gage should rise to and stabilize between 45 and 55 psi.
- (b) If the pressure fails to be maintained within the required range, stop the pump and remove the front cover assembly. Change the number of shims under the governor assist plunger spring (100). Add shims to increase pressure; remove shims to decrease pressure. Reassemble and fill the pump, and recheck the adjustment.
- (c) After testing, open the manifold orifice valve and keep the idle orifice valve closed. Remove the fuel pump from the test stand. Drain all fuel from the pump and close the openings to prevent the entry of dirt.

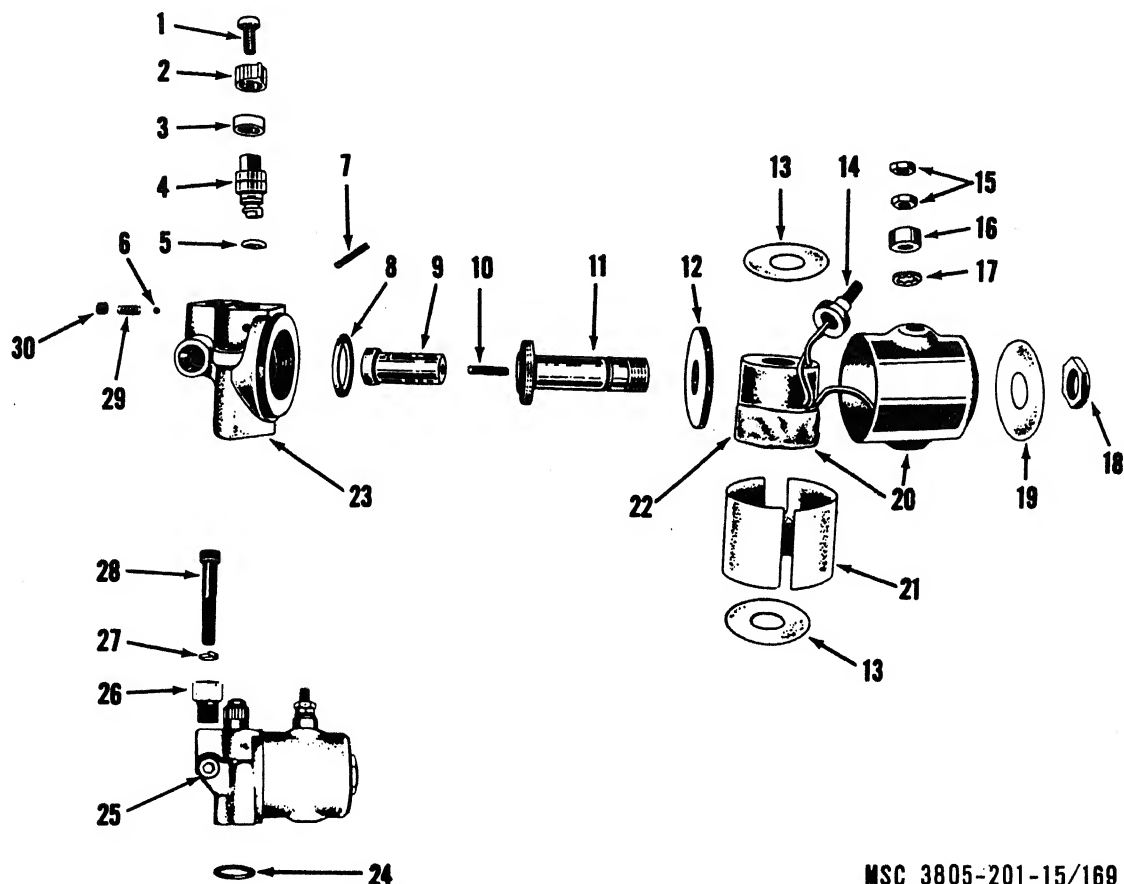
### 239. Fuel Shutoff Valve

*a. General.* The fuel shutoff valve (20, fig. 35) is operated by the ignition switch key. It starts the flow of fuel from the fuel pump to the engine when the ignition switch is turned on, and stops the flow of fuel when the ignition switch is turned off. A manual override knob is provided on the forward end of the fuel shutoff valve. It allows the valve to be opened in case of electric power failure. If the key is turned OFF and then ON while the engine is being pushed by its load, the shutoff valve solenoid may burn out as it tries to open the valve against the buildup fuel pressure.

**Caution:** Never leave the ignition switch key or over-ride knob in the valve open or run position when the engine is not running. This would allow the fuel to drain into engine cylinders, causing a hydraulic lock.

*b. Removal and Disassembly* (fig. 169).

- (1) Disconnect the electrical leads from the fuel shutoff valve. Remove the two screws (28) and lockwashers (27) that secure the fuel shutoff valve to the fuel pump; remove the fuel shutoff valve and the preformed packing (24).
- (2) Remove the nut (18) that secures the



MSC 3805-201-15/169

1 Screw and washer	9 Plunger and insert	17 Lockwasher	24 Preformed packing
2 Over-ride knob	10 Plunger spring	18 Nut	25 Plug
3 Spacer	11 Sleeve	19 Nameplate	26 Outlet connection
4 Over-ride stem	12 Flux plate	20 Coil and terminal housing	27 Lockwasher
5 Preformed packing	13 Coil washer	21 Coil wrapper	28 Screw
6 Detent ball	14 Terminal insert	22 Coil	29 Detent spring
7 Pin	15 Nut	23 Valve body	30 Setscrew
8 Plunger seal	16 Terminal insulator		

Figure 169. Fuel shutoff valve, exploded view.

coil and terminal housing (20) to the sleeve assembly (11); remove the nameplate (19), housing, and flux plate (12).

- (3) If the coil requires replacement, remove the two nuts (15), insulator (16), and lockwasher (17) from the terminal insert; carefully pull the coil (22) out of the housing. Unsolder the leads; remove the coil washers (13), coil wrapper (21), terminal insert (14), and the coil.
- (4) Use a wrench to remove the sleeve (11) from the shutoff valve body (23); remove the seal (8). Remove the plunger and insert (9) and plunger spring (10) from the sleeve.

- (5) Remove the screw and washer (1) that secure the over-ride knob (2); remove the over-ride knob and the spacer (3).
- (6) Remove the pin (7) that secures the over-ride stem (4) to the shutoff valve body; remove the over-ride stem and the preformed packing (5).
- (7) Remove the setscrew (30) that secures the detent spring (29) in the shutoff valve body; remove the detent spring and the detent ball (6).
- (8) Remove the outlet connection (26) and the elbow from the valve body.

#### c. Cleaning and Inspection.

- (1) Check the coil with an ohmmeter to detect an open or short circuit. If the

- coil tests defective or looks or smells as though it has overheated and damaged the insulation, replace the coil.
- (2) Check the soft inserts in the plunger for wear or damage; carefully wipe any dirt from the plunger and sleeve.
  - (3) Check the plunger spring for breakage or distortion.
  - (4) Examine the plunger seat for wear or damage.

**Caution:** Do not clean the seat with any type of cleaning fluid as

damage could result.

- (5) Replace preformed packings, seals, and any parts that are damaged or defective.

*Note.* If the shutoff valve operates with a loud buzzing noise, examine the sleeve assembly and the plunger. Remove any foreign matter imbedded in these parts.

*d. Reassembly and Installation.* Reassemble and install the fuel shutoff valve by reversing the removal and disassembly procedure described in *b* above.

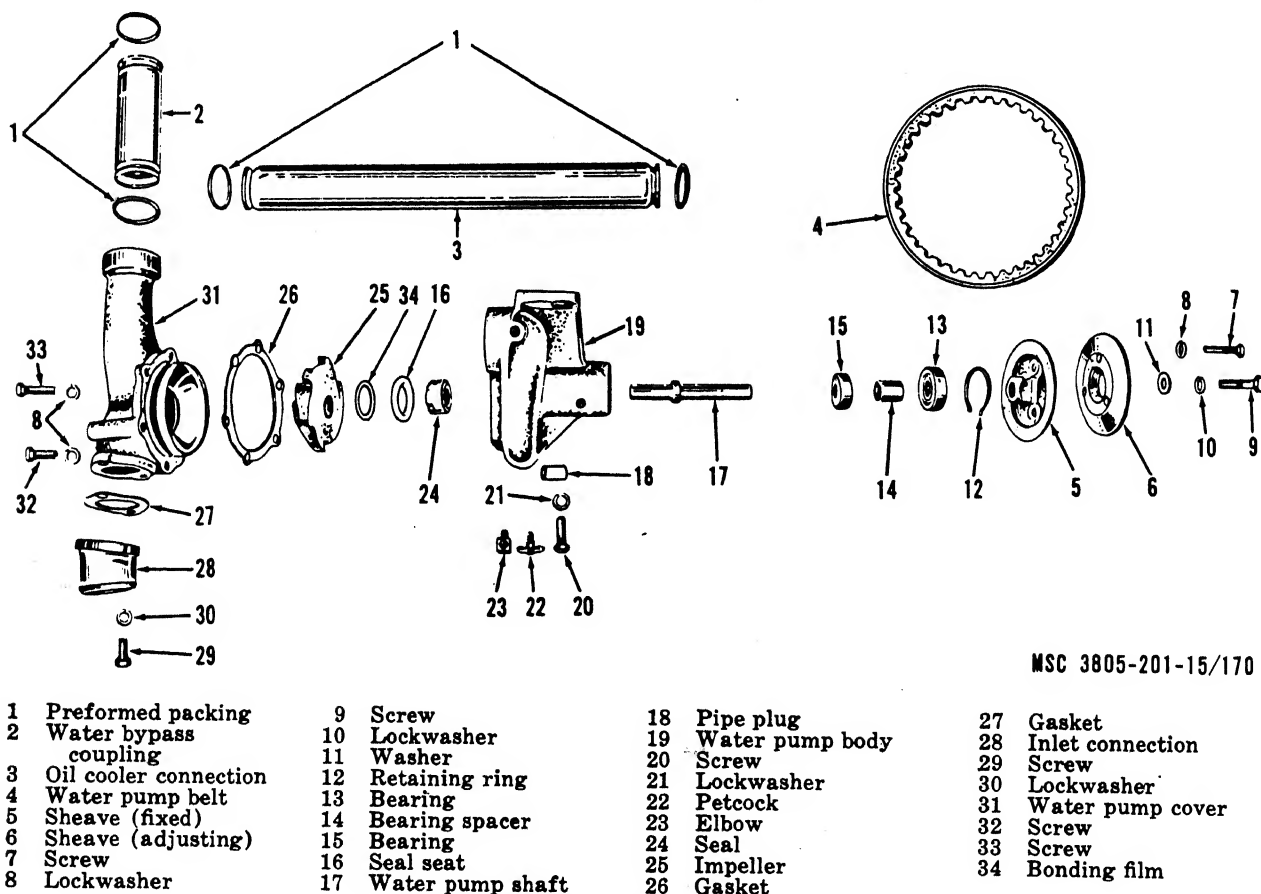
## Section IV. COOLING SYSTEM

### 240. General

*a.* All components of the cooling system except the water pump are completely covered in paragraphs 147 through 152.

*b.* The water pump is used to circulate the engine coolant and is driven by the accessory drive through a belt to the fan pulley. The

water pump belt tension is adjusted by its adjustable pulley. The water pump is a typical centrifugal-type pump which draws the coolant from the bottom of the radiator and forces it through the engine oil cooler into the cylinder water jacket. This makes possible a faster exchange of heat from the operating parts of the



MSC 3805-201-15/170

Figure 170. Water pump, exploded view.

engine to the engine coolant. The water pump is driven at all times while the engine runs.

## **241. Water Pump** (fig. 170)

### *a. Removal and Disassembly.*

- (1) Remove the water pump from the engine as directed in paragraph 150a.
- (2) Remove the screw (9), lockwasher (10), and washer (11) from the water pump shaft.
- (3) Remove the three screws (7) and lockwashers (8) that secure the adjusting sheave (6) to the fixed sheave (5); unscrew and remove the adjusting sheave.
- (4) Pull the fixed sheave from the water pump shaft (17).
- (5) Remove the six screws (32 and 33) and lockwashers (8) that secure the water pump cover (31) to the water pump body (19); remove the water pump cover and gasket (26).
- (6) Remove the two screws (29) and lockwashers (30) that secure the inlet connection (28) to the water pump cover; remove the inlet connection and the gasket (27).
- (7) Remove the retaining ring (12) from the water pump body (19); press the shaft and bearings from the impeller (25) and the water pump body.
- (8) Press the seal (24) from the water pump body.

- (9) Press the bearing (13), spacer (14), and bearing (15) from the water pump shaft (17).

- (10) Remove the pipe plug (18), petcock (22), and the elbow (23) from the water pump body.

### *b. Cleaning and Inspection.*

- (1) Thoroughly clean all parts with an approved cleaning solvent. Remove all rust scale and corrosion from the water pump cover, body, and impeller.
- (2) Inspect the water pump cover, body, and impeller for cracks, breaks, or damage.
- (3) Check the ball bearings for rough or binding operation, excessive looseness, or worn or damaged balls or races.
- (4) Inspect the impeller for cracks, damaged vanes, and distortion. Check the ceramic seal seat (16) on the impeller for wear, cracking, or chipping. If the seal seat is damaged, remove it and install a new seat with bonding film (34).
- (5) Check the shaft and pulley sheaves for excessive wear or damage.
- (6) Replace the gaskets, seal, and all defective parts.

*c. Reassembly and Installation.* Reassemble and install the water pump by reversing the removal and disassembly procedure described in *a* above.

## **Section V. ELECTRICAL SYSTEM**

## **242. Generator**

*a. General.* The battery charging generator is a 4-pole, shunt-type, 24-volt, 40-ampere, dc generator. The current output to the batteries is controlled by the voltage regulator. The generator is belt driven from the engine accessory drive pulley. Air cooling is provided by a fan mounted on the generator drive pulley.

### *b. Removal and Disassembly.*

- (1) Remove the generator from the engine as directed in paragraph 139d. Remove the castellated nut that secures the generator drive pulley (2, fig. 50) to the generator (7); remove the pulley.

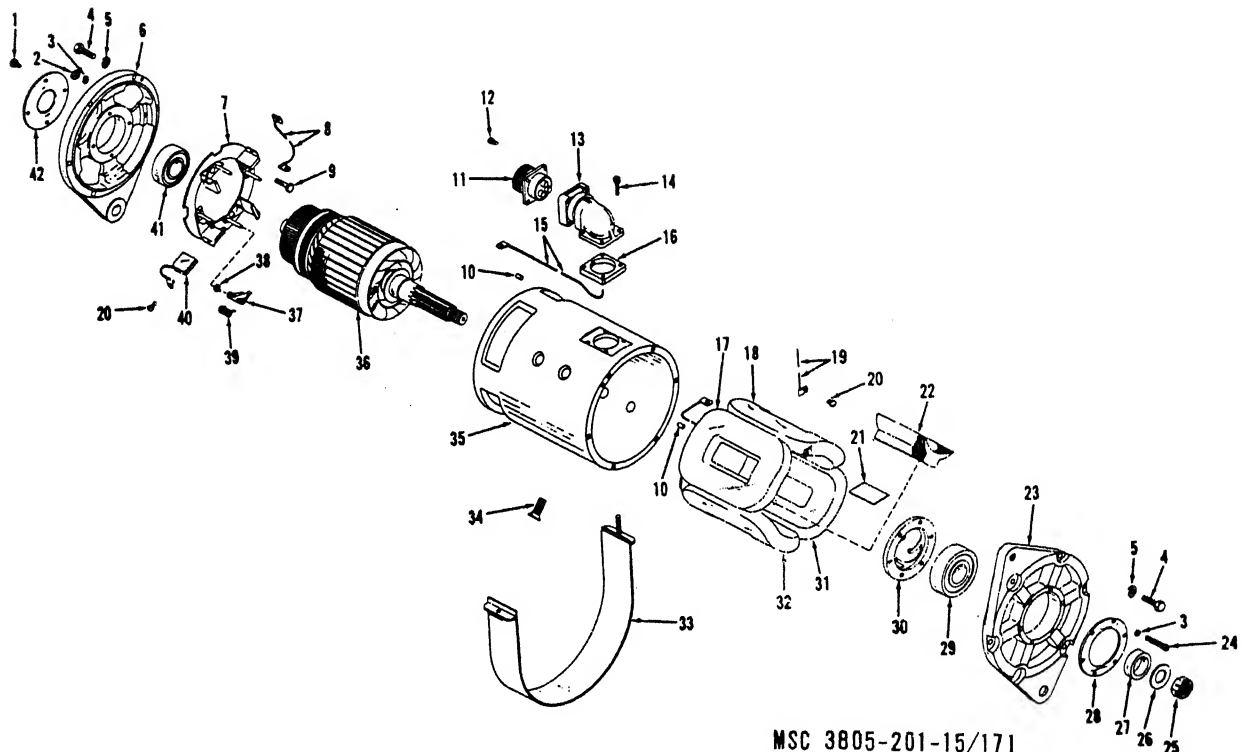
- (2) Turn the screw on the generator cover band (33, fig. 171) until it disengages the nut; remove the cover band.
- (3) Remove the four screws (20) that secure the brush leads and the interconnecting leads. Remove the lead assembly (8); lift the brush arms (37) and remove the four brushes (40).
- (4) Remove the nut (25), washer (26), and collar (27) from the drive end of the armature shaft.
- (5) Remove the six screws (4) and lockwashers (5) that secure the drive end frame (23) to the generator field frame (35); remove the drive end

frame and the armature (36). Remove the bearing (41) from the commutator end of the armature shaft.

- (6) Remove the six screws (24) and lockwashers (3) that secure the bearing retainer plates (30 and 28) to the drive end frame; remove the bearing retainer plates. Press the bearing (29) out of the drive end frame.
- (7) Remove the six screws (4) and lockwashers (5) that secure the commutator end frame (6) to the generator field frame (35); remove the commutator end frame.
- (8) Remove the four screws and lockwashers (1) that secure the end cover plate (42) to the commutator end frame; remove the end cover plate.

Remove the four nuts (2), lockwashers (3), and screws (9) that secure the brush plate assembly (7) to the commutator end frame; remove the brush plate assembly.

- (9) Slide the four brush arms (37), spring (39), and washers (38) off the brush plate assembly.
- (10) Remove the screw (20) that secures the field coil lead (19) to the field coil.
- (11) Remove the four screws and lockwashers (12) that secure the receptacle terminal (11) to the elbow (13); remove the receptacle terminal and leads. Unsolder the leads (15 and 19) from the receptacle terminal; remove the leads.
- (12) Remove the four screws and lockwashers (14) that secure the elbow (13) to



MSC 3805-201-15/171

- |                        |                         |                      |                           |
|------------------------|-------------------------|----------------------|---------------------------|
| 1 Screw and lockwasher | 12 Screw and lockwasher | 24 Screw             | 33 Cover band             |
| 2 Nut                  | 13 Elbow                | 25 Nut               | 34 Pole shoe screw        |
| 3 Lockwasher           | 14 Screw and lockwasher | 26 Washer            | 35 Field frame            |
| 4 Screw                | 15 Brush lead           | 27 Collar            | 36 Armature               |
| 5 Lockwasher           | 16 Spacer               | 28 Outside bearing   | 37 Brush arm              |
| 6 Commutator end frame | 17 Field coil           | 29 Drive end bearing | 38 Washer                 |
| 7 Brush plate assembly | 18 Field coil           | 30 Inside bearing    | 39 Brush spring           |
| 8 Lead assembly        | 19 Field coil lead      | 31 Field coil        | 40 Brush                  |
| 9 Screw                | 20 Screw                | 32 Field coil        | 41 Commutator end bearing |
| 10 Dowel pin           | 21 Insulator            |                      | 42 End cover plate        |
| 11 Receptacle terminal | 22 Pole shoe            |                      |                           |
|                        | 23 Drive end frame      |                      |                           |

Figure 171. Generator, exploded view.

the generator field frame; remove the elbow and the spacer (16).

- (13) Remove the two screws (34) that secure each of the four pole shoes (22) to the generator field frame. Remove the four pole shoes, the four field coils (17, 18, 31, and 32), and the insulators (21); mark the respective position of the field coils in relation to the generator field frame. If necessary, replace individual field coils; note the coil connections before unsoldering the leads.

*c. Cleaning and Inspection.*

- (1) Do not use cleaning solvent to clean any of the generator parts except the end frames and the generator field frame. Clean the remaining parts with compressed air or by wiping with a clean, dry cloth.
- (2) If the armature commutator is worn, dirty, out-of-round, or has high mica, it should be turned down in a lathe and the mica undercut one-thirty-second inch. After undercutting, sand the commutator with No. 00 sandpaper to remove any burs.
- (3) Inspect the brushes; replace if cracked, chipped, or worn to less than half their original length.
- (4) Check the brush spring tension with a spring gage; the proper tension is 28 ounces; correct by bending the spring. Replace the springs if blued or burned from overheating or if broken or distorted.
- (5) The bearings used are the sealed ball type and should not be immersed in any type of cleaning solvent. Check the bearings for excessive looseness and sticking or binding operation.
- (6) Inspect the brush plate assembly for loose or bent brush holders or brush arm studs.
- (7) Check the field coils for a short circuit by connecting a 24-volt battery and an ammeter in series with the normally connected field coils. (In the housing, they would be installed from the B terminal to the generator frame.) The normal current is from 1.00 to 1.05 amperes.

**Caution:** Be careful because a

shorted field could cause damage to the ammeter being used for checking the field coils.

- (8) Repair any damaged insulation if possible; replace all defective parts.

*d. Reassembly and Installation.*

- (1) If any of the field coils (17, 18, 31, and 32, fig. 171) were removed, properly position the new coils and connect all four coils in series.
- (2) Position the field coils in the generator field frame (35), making sure that the terminal connection of the field coil (18) is toward the drive end and adjacent to the opening for the terminal elbow (13).
- (3) Position the four pole shoes (22) and the insulators (21) in the field coils; secure to the field frame with the eight pole shoes screws (34). If available, use a pole shoe spreader and pole shoe screwdriver.
- (4) Position the spacer (16) and the elbow (13) on the generator field frame; secure with the four screws and lockwashers (14).
- (5) Solder the brush lead (15) to the A terminal of the receptacle terminal (11), a jumper from the A terminal to the C terminal, and the field coil lead (19) to the B terminal.

**Caution:** Use solder with rosin flux. Acid flux solder must never be used on electrical connections.

- (6) Run the leads through the elbow and position the receptacle terminal on the elbow; secure with the four screws and lockwashers (12).
- (7) Secure the field coil lead (19) to the field coil (18) with the screw (20).
- (8) Position the four washers (38), brush springs (39), and brush arms (37) on the brush plate assembly (7). Position the brush plate assembly on the commutator end frame (6); secure with the four screws (9), lockwashers (3), and nuts (2).
- (9) Position the end cover plate (42) on the commutator end frame; secure with the four screws and lockwashers (1).
- (10) Aline the commutator end frame with



- the dowel pin (10) on the commutator end of the generator field frame; secure with the six screws (4) and lockwashers (5).
- (11) Install the bearing (29) in the drive end frame (23). Position the inside bearing retainer plate (30) and the outside bearing retainer plate (28) on the drive end frame; secure with the six screws (24) and lockwashers (3).
  - (12) Install the bearing (41) on the commutator end of the armature shaft.
  - (13) Position the armature (36) in the generator field frame. Aline the drive end frame with the dowel pin (10) on the generator field frame. Slide the drive end frame into position over the armature shaft; secure with the six screws (4) and lockwashers (5).
  - (14) Position the collar (27) on the armature shaft; install the washer (26) and nut (25) on the armature shaft.
  - (15) Lift the brush arms (37) and install the four brushes (40). Position the interconnecting lead (8) between the two insulated brush holders; position the brush lead (15) on one of the insulated brush holders; position the field coil lead on one of the grounded brush holders. Secure the leads from the brushes and the interconnecting leads with the four screws (20). Check to be sure that all leads are connected to the proper holders and that none are shorted to the brush plate or the generator frame.
  - (16) Position the generator cover band (33) over the commutator openings; secure with the cover band screw. Install the drive pulley (2, fig. 50); secure with a castellated nut.
  - (17) Install the generator on the engine as directed in paragraph 139f.
  - (18) Polarize the generator as directed in paragraph 139g.

## 243. Voltage Regulator

*a. General.* The voltage regulator is a watertight, corrosion- and fungus-resistant unit designed for use with a generator having an internally grounded field circuit, and in a system with a negative ground. The regulator is composed of three units; a cutout relay, voltage reg-

ulator, and current regulator. The cutout relay closes the circuit to the batteries when the generator builds up enough current to charge the batteries. The voltage regulator regulates the generator output to the batteries within preset limits. The current regulator regulates the amount of current being delivered to the batteries.

### *b. Adjustments.*

- (1) Remove the voltage regulator from the engine as directed in paragraph 140a.
- (2) Remove the four screws and lockwashers and the two seal cups that secure the cover to the regulator base assembly; remove the cover.

*Note.* The generator regulator must be in operating position when being adjusted or checked. Power to the regulator must be shut off when making adjustments. All checks must be made with the regulator at operating temperature and connected to the same type of dc generator used on the engine. Replace the cover after each adjustment and operate the generator until the regulator returns to its normal operating temperature. The voltage and current regulator checks must be made with the generator speed equal to the maximum speed reached by the vehicle engine in service.

- (3) Clean the contact points of the regulator when they show signs of oxidation and pitting. Oxidation of the contacts reduces the generator output. Clean the thicker (tungsten) contact points with a riffler file until the oxidation is removed. Clean the thinner (platinum) contact with crocus cloth; wash with an approved cleaning solvent to remove any oily film. Blow the filings from the unit with compressed air to prevent them from becoming embedded in the contact surfaces.

**Warning:** Do not file the contact points excessively. Never use sandpaper or emery cloth. Use a clean ignition file.

**Caution:** Air gap and point gap openings are checked with the battery disconnected.

- (4) Measure the air gap of the cutout relay between the armature and the core with the contact points barely touching. The air gap should be 0.037 inch. If the points do not close, aline the

lower contact bracket or slightly bend the spring fingers on the armature until the points meet and aline. Adjust the air gap by loosening the two screws attaching the lower contact bracket. Raise or lower the contact bracket as required. Aline the contact points and tighten the screws. Measure the contact point opening; it should be 0.037 inch. Adjust to obtain the correct contact point opening by bending the upper armature stop. To check the closing voltage, insert a wiring harness in the generator circuit as shown in figure 172. Connect a voltmeter and a variable resistor in the circuit.

**Caution:** The cutout relay contact points must never be closed by hand with the battery connected to the voltage regulator. This would cause high current to flow through the units and seriously damage them.

- (5) Gradually increase the speed of the generator until the relay contacts close. Note the voltage; it should be between 25 and 27 volts. If the closing voltage is not within this range, adjust by loosening the lock and eccentric screw at the base of the cutout relay frame. The eccentric screw increases or decreases the tension of the spiral spring. Increasing the spring tension increases the relay closing voltage; decreasing the spring tension decreases the closing voltage. When the proper adjustment is secured, tighten the lock screw.

**Caution:** The generator must be cycled before each check and adjustment. Cycle the generator by reducing the generator speed until the cutout relay opens; then increase the speed slowly until the proper speed for checking is reached.

- (6) Measure the air gap. Push the armature down until the points open; release until the points barely close. Measure the air gap at the point between the armature and the part of the core next to the residual pin. Do not measure the gap when the flat spring that supports the contact screw is raised up off the fiber mounting plate.

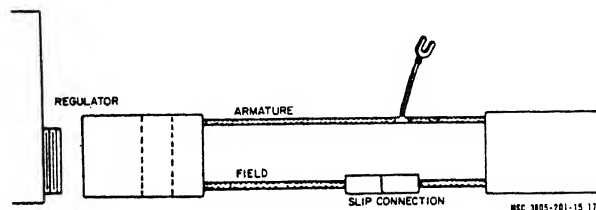


Figure 172. Wiring harness for checking cutout relay.

The air gap should be 0.084 inch. Adjust by loosening the locknut and turning the contact screw. This can be done most conveniently by inserting the flat gage in the air gap, pressing down on the armature to hold it in place, and turning the contact setscrew until the contacts barely touch. Check the voltage setting. Insert the special wiring harness shown in figure 173, leaving the connections open.

**Caution:** Make sure the ends of the leads are insulated from the ground at all times to avoid a short circuit.

- (7) Connect a voltmeter between the connection from the regulator to ground. Cycle the generator as directed in (5) above. With the generator operating at 400 rpm and the regulator at operating temperature, note the voltage registered on the voltmeter; it should be between 27.5 and 29.5 volts. If the voltage is not within this range, adjust by loosening the lock and eccentric screws at the base of the voltage regulator frame. The eccentric screw increases or decreases the tension of the spiral spring. Increasing the spring tension increases the closing voltage; decreasing the spring tension decreases the closing voltage. Adjust to 28.2 volts. Cycle the generator after each change of adjustment.
- (8) Measure the air gap of the current regulator by the same method to measure the air gap of the voltage regulator. The air gap between the armature and that part of the core next to the residual pin should be 0.115 inch. Adjust the air gap by loosening the locknut and turning the contact screw.

Tighten the locknut after the proper setting is obtained. Check the current regulator setting by connecting an accurate ammeter to the leads of the special wiring harness (fig. 173) in the battery circuit. Voltage regulator operation must be prevented during this check and can be done by partly discharging the battery with a carbon pile load approximating the current regulator setting inserted across the battery terminals during the time the current regulator setting test is made. When the generator output is increased to maximum, the current should be 38 to 42 amperes, but this must be measured before rising battery voltage causes the voltage regulator to operate. If the amperage is not within this range, adjust by loosening the lock and eccentric screw at the base of the current regulator frame. The eccentric screw increases or decreases the tension of the spiral spring. Increasing the spring tension increases the relay closing amperage; decreasing the spring tension decreases the closing amperage. When the proper setting is obtained, tighten the lock screw. After each change of adjustment, reduce the generator speed until the cutout relay opens; then return to speed and check the current indication on the ammeter.

- (9) Install the voltage regulator on the engine as directed in paragraph 140c.

## 244. Starting Motor and Solenoid Switch

*a. General.* When the ignition switch is closed, a circuit is completed with the solenoid switch (62, fig. 174) mounted on the starting motor. The solenoid switch in turn closes the circuit to the starting motor, causing it to rotate the gear of the motor drive assembly (51). Simultaneously, the solenoid pivots the lever arm assembly (41), which moves the motor drive assembly so that the gear meshes with the ring gear of the engine flywheel. As the motor drive assembly is turned, it turns the ring gear of the engine to start the engine cycle. When the engine fires and starts, the overrunning clutch in the motor drive assembly moves the drive gear out of engagement with the flywheel.

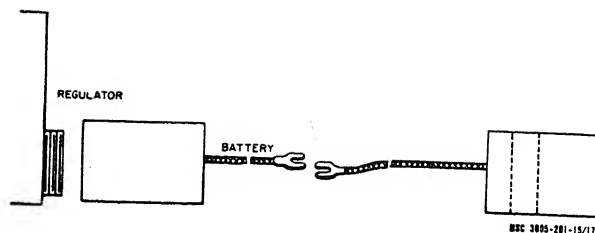


Figure 173. Wiring harness for checking voltage and current regulator.

ring gear so that the starting motor is not driven by the engine.

### *b. Removal and Disassembly.*

- (1) Remove the starting motor from the engine as directed in paragraph 141b.
- (2) Remove the two capscrews (67, fig. 174) that secure the plate (66) and boot (69) to the solenoid switch (62); remove the plate. Pull the boot back far enough to provide access to the couplings (55). Remove the two cotter pins (57) from the solenoid plunger linkage and remove the couplings (55).
- (3) Remove the nuts (46) and lockwashers (9) from the terminals on top of the solenoid switch; remove the nut (1) and guard washer (3) from the jumper assembly (16) on the commutator end housing (12); remove the lead assembly (7) and the jumper (58). Remove the capscrew (59) on the side of the solenoid switch. Remove the nut (1) and lockwasher (2) from the terminal screw (35); remove the lead assembly (30).
- (4) Remove the four screws (61) and lockwashers (60); remove the solenoid switch (62) from the field frame (37).
- (5) Remove the coupling retainer (13, fig. 175) from the threaded shaft (30); remove the spring retainer (14), spring (15), retainer (16), and felt washer (18).
- (6) Remove the front bracket (20) and plate and bushing assembly (21) from the shell assembly (1). Pull the shaft (30) with the plunger (31) and contact assembly (28) from the shell. Re-

- move the retainer washer (22) from the shaft.
- (7) Remove the retaining ring (23) from the shaft (30); remove the retaining washers (24), insulating washers (25), contact bushing (26), spring (27), contact assembly (28), and spacer (29) from the shaft. Unscrew the shaft from the plunger (31).
  - (8) Remove the nuts (9), lockwashers (10), and guard washers (11) from the terminal screws (8). Push the terminal screws to the inside of the contact housing (12); remove the contact housing.
  - (9) Remove the screws (2) from the shell assembly (1); pull the yoke (5), coil assembly (4), sleeve (7), tubing (6), and terminal screws (8) as a unit from the shell assembly. Remove the seal ring (3) from the shell assembly. If it is necessary to replace the yoke, coil, sleeve, tubing, or a terminal screw, unsolder the connections at the terminal screw; separate the yoke from the coil; remove the sleeve from the coil; pull the tubing from the yoke.
  - (10) Remove the band assembly (27, fig. 174); remove the screws (18) to disconnect the brushes (19); lift the springs in the brush holder assembly (21); remove the brushes. Remove the brush holder jumper (25), lockplates (17), and screws (18) from the starter housing.
  - (11) Match-mark the commutator end housing (12), field frame (37), drive end housing (52), and drive housing (48) to assure proper reassembly.
  - (12) Remove the screws (47 and 49) and lockwashers (9) that secure the boot bracket (68) and drive housing (48) to the field frame (37); remove the boot bracket and the assembled drive housing and drive assembly (51). The boot (69) is cemented to the drive housing (48). Break the cemented joint between the parts and remove the boot.
  - (13) Remove the roll pin (42) from the lever arm shaft (43) and pull the lever arm assembly (41) toward the top of the drive housing (48) to disengage

the lever arm assembly cams from the drive assembly (51); remove the drive assembly from the drive housing. The drive thrust washer (50) will fall to the bench.

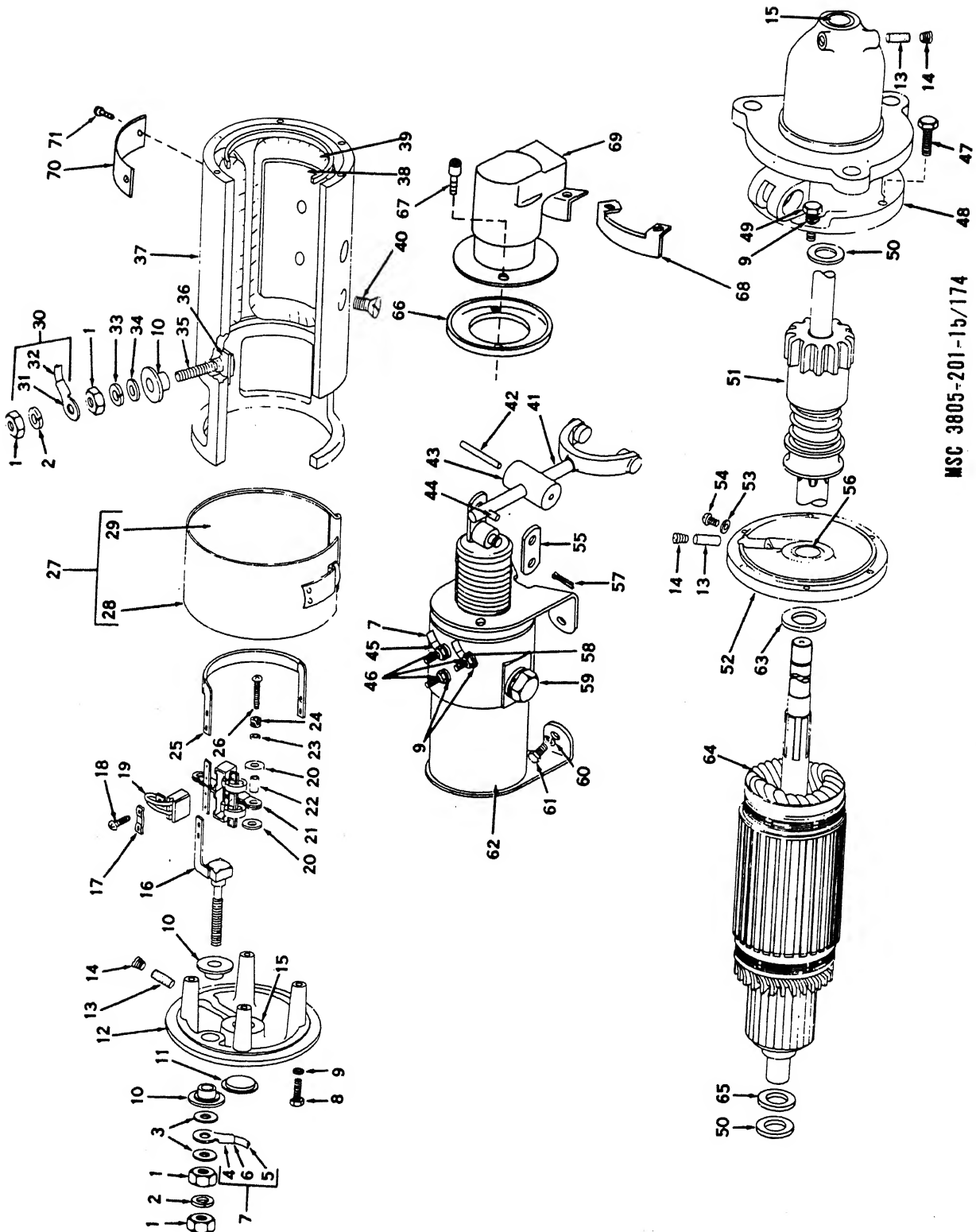
- (14) Remove the lever arm assembly (41) and lever arm shaft (43) from the drive housing. Remove the plug (14) and felt wick (13) from the drive housing.
- (15) Remove the drive end housing (52) from the field frame (37). Remove the plug (14) and felt wick (13) from the drive end housing. Remove the thrust washer (63) from the armature assembly shaft.
- (16) Pull the armature assembly (64) from the field frame. Remove the thrust washers (50 and 65) from the armature assembly.
- (17) Remove the screws (8) and lockwashers (9) that secure the commutator end housing (12) to the field frame (37); remove the end housing. Remove the screws (26), lockwashers (24), and guard washers (23) that secure the brush holder assemblies (21) to the commutator end housing. Disassemble the insulation washers (20) and insulation bushing (22). Remove the plug (14) and felt wick (13) from the commutator end housing.
- (18) Remove the jumper assembly (16) from the commutator end housing (12); remove the insulation bushings (10).

*Note.* The field coils should be removed only if checking (subparagraphs c (18) and (19)) reveals that they have open or shorted coils.

- (19) Remove the nut (1), lockwasher (33), and guard washer (34) from the terminal screw (35); push the screw inside the field frame; remove the insulation bushing (10) and the insulator (36).
- (20) Remove the screws (40) that secure the pole pieces (38) to the field frame (37); remove the pole pieces and field coil assembly (39).

*c. Cleaning and Inspection.*

- (1) Clean the solenoid switch, armature, field coils, brush plate assembly, and



MSC 3805-201-15/174

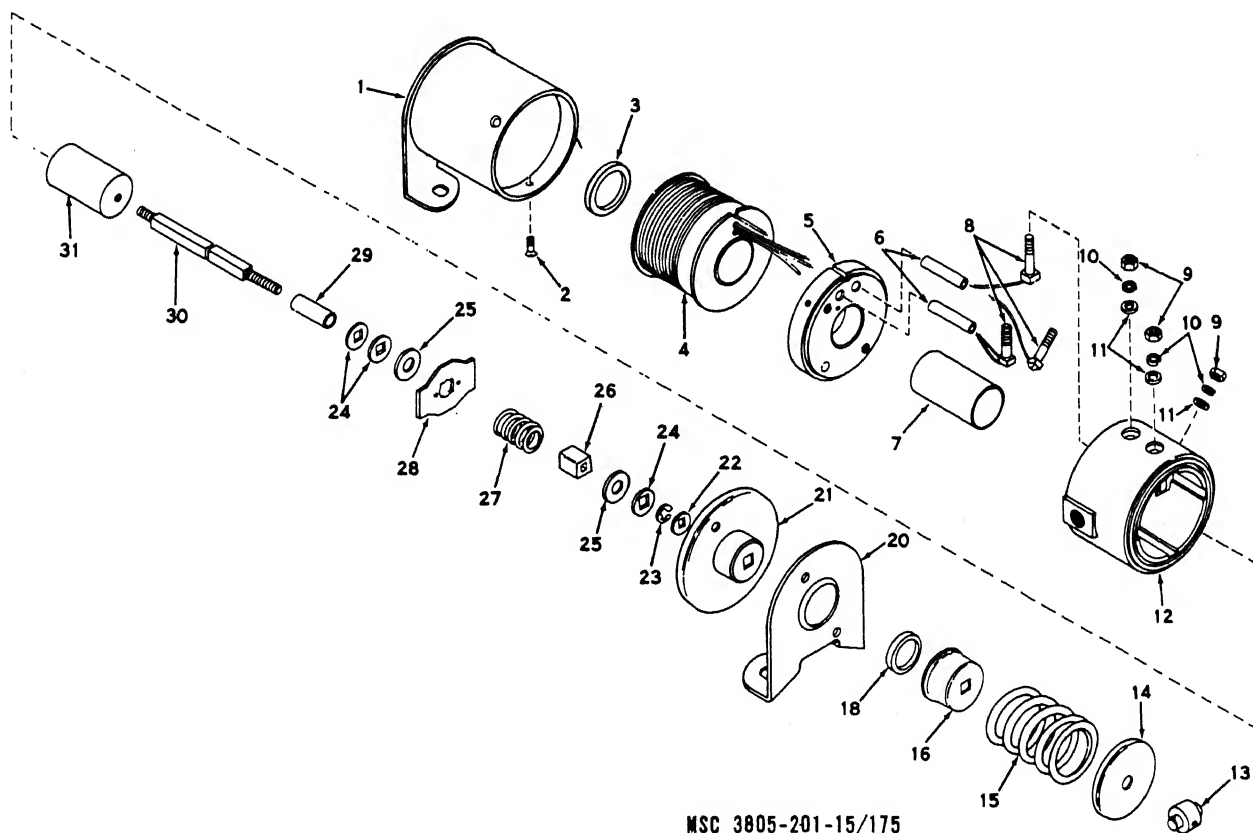
Figure 174. Starting motor, exploded view.

1 Nut	19 Brush	36 Insulator	54 Screw
2 Lockwasher	20 Insulation washer	37 Field frame	55 Coupling
3 Guard washer	21 Brush holder assembly	38 Pole piece	56 Bushing
4 Terminal	22 Insulation bushing	39 Field coil assembly	57 Cotter pin
5 Cable	23 Guard washer	40 Screw	58 Jumper
6 Sleeving	24 Lockwasher	41 Lever arm assembly	59 Capscrew
7 Lead assembly	25 Brush holder jumper	42 Roll pin	60 Lockwasher
8 Screw	26 Screw	43 Lever arm shaft	61 Screw
9 Lockwasher	27 Band assembly	44 Roll pin	62 Solenoid switch
10 Insulation bushing	28 Band and clip	45 Terminal	63 Thrust washer
11 Dust cap	29 Gasket	46 Nut	64 Armature assembly
12 Commutator end housing	30 Lead assembly	47 Screw	65 Thrust washer
13 Felt wick	31 Terminal	48 Drive housing	66 Plate
14 Plug	32 Cable	49 Screw	67 Capscrew
15 Bushing	33 Lockwasher	50 Thrust washer	68 Bracket
16 Jumper assembly	34 Guard washer	51 Drive assembly	69 Boot
17 Lockplate	35 Screw	52 Drive end housing	70 Identification plate
18 Screw		53 Lockwasher	71 Drive screw

Figure 174—Continued.

drive assembly with a cloth dampened in an approved cleaning solvent or oleum spirits. Dry with clean, dry compressed air.

(2) Wipe the outside of the drive assembly with a cloth lightly dampened in solvent. Clean all other metal parts thoroughly with an approved cleaning sol-



MSC 3805-201-15/175

1 Shell assembly	9 Nut (1384)	18 Felt washer	25 Insulating washer
2 Screw	10 Lockwasher	20 Front bracket	26 Contact bushing
3 Seal ring	11 Guard washer	21 Plate and bushing assembly	27 Spring (1395)
4 Coil assembly	12 Contact housing	22 Retainer washer	28 Contact assembly
5 Yoke	13 Coupling retainer	23 Retaining ring	29 Spacer
6 Tubing	14 Spring retainer	24 Retaining washer	30 Shaft
7 Sleeve	15 Spring		31 Plunger
8 Terminal screw	16 Retainer		

Figure 175. Solenoid switch, exploded switch.

vent. Use a wire brush to thoroughly clean the screw threads. Dry with clean, dry compressed air.

**Caution:** The drive assembly should never be immersed in cleaning fluid.

- (3) Clean the armature commutator with No. 00 sandpaper. DO NOT USE EMERY CLOTH TO CLEAN THE COMMUTATOR.
- (4) Clean the insulators, insulating washers, insulated spacers, and brushes (if they are to be re-used) with a clean, coarse cloth.
- (5) Inspect the drive housing, commutator end housing, drive end housing, field ring, and solenoid shell and brackets for cracks, breaks, damaged threads, or other defects.
- (6) Inspect the armature for rough spots, pitting, burning, high mica, broken windings, or eccentricity. Inspect the armature shaft for bending or scoring. Check to see that there are no breaks where the armature conductors join the commutator bars. Repair any breaks by soldering with rosin flux solder.
- (7) Inspect brushes for cracks, breaks, or wear to less than nine-sixteenth inch.
- (8) Inspect the brush springs for distortion or weakness. Spring tension should be 45 to 50 ounces when brushes are installed.
- (9) Inspect the armature shaft bushings for excessive wear or scoring.
- (10) Inspect the drive assembly for a broken spring, cracks, chipped or broken gear teeth, or other defects.
- (11) Inspect oil wicks for "packing" and cleanliness.
- (12) Inspect all field coil and brush wire leads for good condition and cracks or deterioration of insulation.
- (13) Replace all parts that are defective, unserviceable, or excessively worn.
- (14) If the commutator is rough or dirty, mount the armature on a lathe and clean it with 200-grit aluminum oxide cloth. If the armature commutator is excessively worn or out-of-round, it should be turned down in a lathe. Do not undercut after turning down.

Polish the commutator lightly with No. 00 sandpaper.

- (15) Inspect the solenoid switch contact points for rough spots, pitting, or burning.
- (16) Test for short circuits in the armature windings using a growler and a metal strip or hacksaw blade. If a short is detected, before discarding, check for brush or copper dust between the commutator bars that may be causing the short.
- (17) Check the armature for grounds using a 500-volt continuity tester. Connect one test lead to the armature shaft or core and the other test lead to the commutator. The armature is grounded if the tester indicates a closed circuit. Before discarding, check for accumulations of brush dust between the commutator bars and steel commutator ring that may be causing the ground.
- (18) Use the 500-volt continuity tester to check for grounds between the field frame and field coils. Connect one of the test line leads to the field frame and the other test lead to the field connector. If a circuit exists, at least one field coil is grounded; replace the field coil assembly.
- (19) Connect the test leads of a 110-volt continuity tester across the ends of each field coil to check for field coil openings. The tester should indicate that a circuit exists. If an open circuit is indicated, replace the defective field coil assembly.
- (20) With the solenoid switch assembled, use a continuity tester to check each of the five terminals for a ground to the switch base. If any terminal is grounded, replace the defective part or parts. No circuit should exist between the two main contact terminals.
- (21) The resistance between terminals 1 and 4 (at room temperature) should be 2.20 ohms. Resistance between terminals 1 and 5 (at room temperature) should be 0.515 ohm.
- (22) Apply 24 volts to terminals 1 and 4, and 1 and 5 to see that the plunger and shaft operate properly.



*d. Reassembly and Installation.*

- (1) Place the pole pieces (38, fig. 174) and field coil assembly (39) in the field frame (37) and secure with the screws (40).
- (2) Place the insulator (36) on the screw (35) and install the screw. Place the insulation bushing (10), guard washer (34), and lockwasher (33) on the screw (35) and secure with the nut (1).
- (3) If necessary to replace the commutator end housing bushing (15), remove the dust cap (11), press the bushing from the housing, press the new bushing into the housing, and ream to 0.753 plus or minus 0.001 inch. Replace the dust cap.
- (4) Place the insulation bushing (10) on the jumper assembly (16) and install the jumper assembly in the commutator end housing (12). Install the insulation bushing (10), guard washers (3), and lead assembly (7) on the jumper; secure with the nut (1).
- (5) Place the lockwashers (24) and guard washers (23) on the screws (26). Assemble the insulation washers (20), brush holder assemblies (21), and insulation bushings (22) on the screws (26); secure to the commutator end housing (12). Install the brush holder jumper (25) and lockplates (17); secure with the screws (18).
- (6) Aline the match marks and position the commutator end housing (12) on the field frame (37); secure with the screws (8) and lockwashers (9). Install the felt wicks (13). Lubricate with oil per MIL-L-2104A and install the plug (14).
- (7) Place the thrust washers (50 and 65) on the armature shaft. Install the armature assembly (64) in the field frame (37), inserting the end of the armature shaft in the commutator end housing bushing (15).
- (8) If necessary to replace the drive end housing bushing (56), press the old bushing from the housing, install the new bushing, and rearm to 0.875 plus or minus 0.001 inch.
- (9) Place the thrust washer (63) on the armature shaft; install the drive end housing; aline the match marks.
- (10) Install the lever arm shaft (43) in the drive housing (48); install the lever arm assembly (41) through the hole in the lever arm shaft and push as far into the drive housing as possible. Coat the armature shaft splines and the shaft collar of the drive assembly with molybdenum disulfide grease, Military Specification MIL-G-10924.
- (11) Position the boot (69) over the lever arm assembly and cement it to the drive housing (48). Install the drive assembly (51) and thrust washer (50) on the shaft and install the drive housing, alining the match marks. Position the bracket (68) on the drive housing and on the boot and secure to the housing with two screws (49) and lockwashers (9). Install the remaining screws (47). Push down the boot and engage the shifting cams of the lever arm assembly with the drive assembly shift collar. Install the roll pin (42) in the lever arm shaft (43); secure by prick-punching. Pull the boot over the lever.
- (12) Install the felt wicks (13) and plugs (14) in the drive end housing (52) and drive housing (48); lubricate with oil per MIL-L-2104A. Install the brushes (19); secure with screws (18). Install the band assembly (27).
- (13) Insert the tubing (6, fig. 175) of the switch assembly through the holes in the yoke (5); push the leads from the coil (4) through the tubing. Solder the terminal screws (8) to the coil leads. (Black leads are soldered to the No. 1 terminal, the red lead to No. 5, and the yellow lead to No. 4).
- (14) Install the sleeve (7) in its hole in the yoke (5), and coil (4); place the seal ring (3) in the shell assembly (1); install the coil and yoke assembly in the shell assembly; secure with the screws (2).
- (15) Place the contact housing (12) in position on the yoke (5); install the terminal screws (8) in their respective holes in the contact housing (No. 1 terminal, two black leads, in the top

hole nearest the coil; No. 4 terminal, yellow lead, in top hole farthest from the coil; and No. 5 terminal, red lead, in the side hole). Secure the terminals with the guard washers (11), lockwashers (10), and nuts (9).

- (16) Turn the threaded end of the shaft (30) into the plunger (31). Install the spacer (29), two retaining washers (24), an insulating washer (25), the contact bushing (26), contact assembly (28), spring (27), an insulating washer (25), and the retaining washer (24) on the shaft (30); secure with a retaining ring (23).
- (17) Install the plunger and shaft assembly in the sleeve (7) with the contact assembly (28) in a horizontal position. Place the retainer washer (22) on the shaft (30); position the plate and bushing assembly (21) and front bracket (20) on the contact housing (12).
- (18) Place the felt washer (18) on the bushing (21); install the retainer (16) over the felt washer. Install the spring (15) and spring retainer (14); compress the spring and screw coupling retainer (13) onto the shaft (30).
- (19) Place the solenoid switch assembly (62, fig. 174) on the field frame (37); secure with the screws (61) and lockwashers (60). Install the two solenoid couplings (55) and secure with the cotter pins (57).
- (20) Position the plate (66) on the boot (69) and install the two capscrews (67) to secure the plate and boot to the solenoid switch (62).
- (21) Apply 6 volts across switch terminals 1 and 4, and push the plunger in manually until the plunger bottoms. (The switch will then hold the plunger in.) With the plunger in this position, the clearance between the drive pinion of the drive assembly (51) and thrust washer (50) must be 0.005 to 0.030

inch. If clearance is not within limits, remove the couplings (55) and screw the coupling retainer (13, fig. 175) farther onto the shaft (30) to decrease the clearance. Back the coupling off to increase the clearance.

- (22) Connect the lead assembly (7, fig. 174) to the terminal on top of the solenoid switch; secure with the nut (46) and lockwasher (9). Connect the jumper (58) to the terminal on the solenoid switch; secure with the nut (46) and lockwasher (9). Connect the lead assembly (30) to the terminal screw (35); secure with the lockwasher (2) and nut (1). Secure the lead to the solenoid switch with the capscrew (59).
- (23) Test the starting motor and solenoid switch as directed in *e* below.
- (24) Install the starting motor as directed in paragraph 141*d*.

#### *e. Testing.*

- (1) Rotate the starting motor by hand to determine that it is free from binding. Connect a 12-volt battery, with electrolyte at a specific gravity of approximately 1.250, across the terminals of the starting motor. The direction of rotation at the drive end must be clockwise, current draw approximately 85 to 90 amperes, and motor speed approximately 3,800 rpm.

**Caution:** Do not run the motor more than 15 seconds at a time when conducting this test.

- (2) Connect 14.5 volts across terminals 1 and 5 of the starting motor solenoid switch. The switch should close. Gradually reduce the voltage. The switch should remain closed until the voltage is 5.0 or less. At 24 volts, the current draw across terminals 1 and 5 should be 58.0 amperes. The current draw across terminals 1 and 4 should be 11.0 amperes.

## Section VI. HYDRAULIC SYSTEM

### 245. Description (fig. 97)

- a. The hydraulic system uses a common oil

reservoir (1) with the steering hydraulic system. A hydraulic pump (6) draws oil from the reservoir and delivers it to the hydraulic valve

(32). The valve directs the oil to the boom cylinders (13 and 28) and bucket cylinder (21) in response to the control lever positions.

b. The hydraulic pump is a double-vane type unit, with both vanes integral on a single shaft. The common suction port is in the center housing and the discharge ports are in the end caps. The capacity of the larger discharge port is 35 gpm at 100 psi when driven at 1,200 rpm. The smaller port delivers 8 gpm at 100 psi when driven at 1,200 rpm. The pump vanes operate between floating port plates. These plates move axially so that hydraulic pressure can be utilized to counteract internal pressure which tends to separate the elements of the cartridge when the pump is delivering pressure to the hydraulic circuit.

c. The main hydraulic valve, mounted on the hydraulic manifold (2), receives hydraulic oil from the main hydraulic pump and directs and controls its flow in the boom, bucket, and clam cylinder circuits. When the boom control lever is moved to the rear, its corresponding plunger in the main control valve directs the flow of oil into the proper hose to move the boom upward. When the bucket and accessory control lever is moved to the rear, its corresponding plunger in the main control valve directs the flow of oil into the proper hose to tip the bucket backward. When the control levers are moved forward, the control valve plungers are positioned to lower the boom and to tip the bucket forward. When the bucket and accessory control lever is moved to the left, the bucket clam opens; when moved to the right, the bucket clam closes. When neither control lever is being operated and the plungers are in neutral position, the oil flowing into the valve is vented through the valve and into the hydraulic reservoir. When one of the plungers is not in neutral position, the free flow through the valve is blocked, creating a pressure within the valve and the boom or bucket circuit. This pressure is controlled by a relief valve in the main control valve body, which relieves pressures over 2,000 psi and vents the excess oil to the reservoir.

d. The boom cylinders (13 and 28) and bucket cylinder (21) are similar in operation. The boom cylinder rod has a 43-inch stroke while the rod for the bucket cylinder has a 22-inch stroke. When the hydraulic valve is ported so that oil is directed to the boom cylinders to raise the boom, it flows through the tubes (9

and 30) and hoses (16) and exerts pressure against the face of a piston inside the cylinder. The hydraulic force moves the piston rod out; oil on the other side of the piston is then ported back to the reservoir through the tubes (10 and 31) and hoses (16). As the piston moves, it moves the rod outward. The rod is connected to the boom and the outward motion of the rod raises the boom. The rod and piston are both sealed by packings; the rod also moves against a wiper seal. When the control valve is ported in the opposite direction by the position of the control levers, the hydraulic oil is directed to the opposite port through the tubes (10 and 31) and hoses (16). The hydraulic oil exerts a force on the opposite face of the piston, forcing the piston and rod in the opposite direction and retracting the rod.

e. Two clam cylinders are mounted on the bucket. They control the opening and closing of the clam-type bucket. They connect to the swivel connectors (20) on the tubes (18 and 25).

f. The hydraulic oil reservoir (1) is mounted on the rear of the manifold enclosure at the right side of the loader. A dipstick is provided at the top of the reservoir to indicate the oil level. A filter, screen, and sediment trap in the reservoir act to remove foreign matter from the oil. A drain plug is provided in the bottom of the reservoir.

## 246. Hydraulic Pump

a. *Removal and Disassembly* (fig. 176).

- (1) Remove the hydraulic pump as directed in paragraph 208a.
- (2) Remove the screws (1), end cap (2), and rear port plate (37). Be certain not to damage the wear face of the port plate.
- (3) Remove the preformed packing (12).
- (4) Using the two 10-24 tapped holes located on the side of the cam ring (15), remove the rotor (14), cam ring (15), vanes (16), vane springs (36), and spring guides (8) as an assembly; lay on a flat, clean surface.

**Warning:** The vanes (16) are held against cam ring (15) by tension from springs (36) in the rotor (14). If rotor is pulled from the cam ring with no protection, tension from springs will cause the vanes to be thrown forcibly out from the rotor in

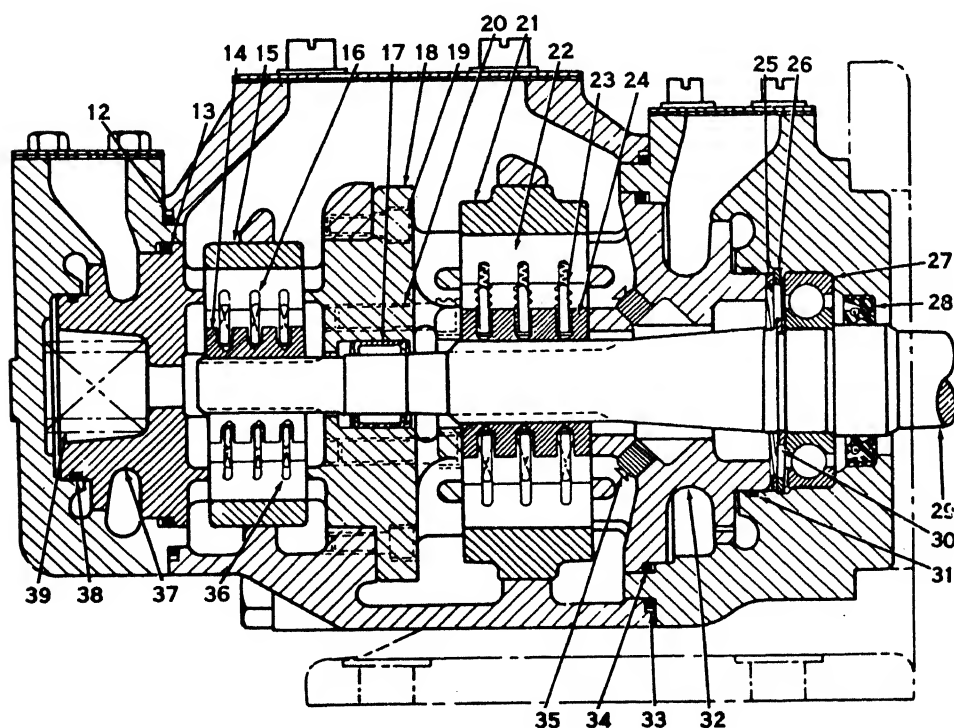
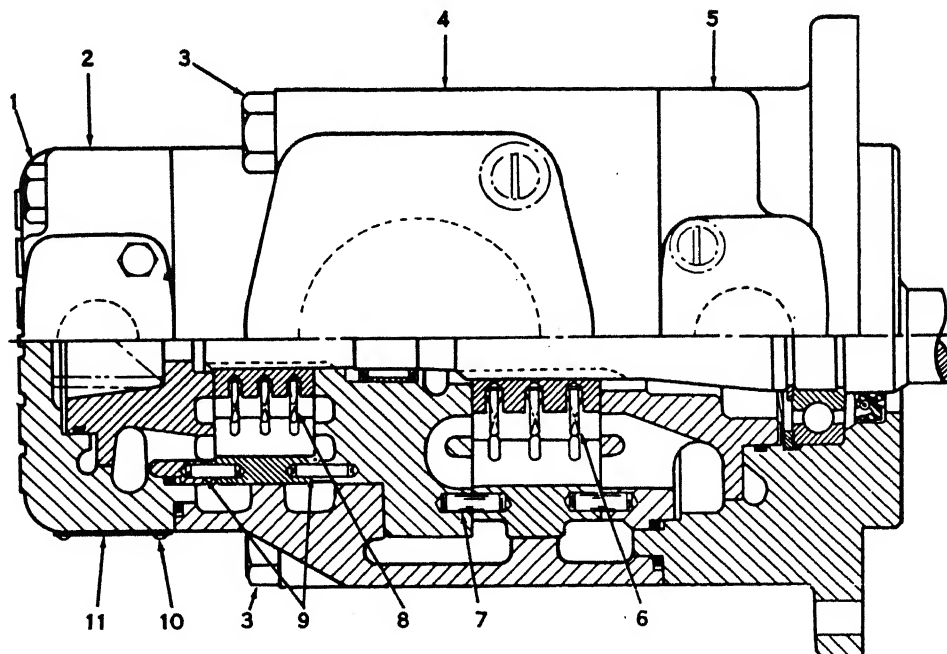
all directions. Serious injury may result since the vanes have fine, sharp edges.

- (5) Push the rotor (14) and vanes (16) simultaneously out of the cam ring (15) far enough so that a ring compressor can be securely fastened around the vanes. Once the ring compressor is in place, push the rotor and vanes the remainder of the way out of the cam ring. Ease the tension of the ring compressor slowly so that the vanes do not fly out of the rotor.
- (6) Remove the screws (3). Remove the assembled center housing (4), center port plate (18), needle bearing (17), cam ring (21), vanes (22), springs (23), rotor (24), and spring guides (6) as a unit.

*Note.* Be certain when removing the above parts that the bearing race on the shaft and the needle bearing are not damaged.
- (7) Using the two 10-24 tapped holes located on the side of the cam ring (21), remove the cam ring, vanes (22), vane spring (23), rotor (24), and spring guides (6) as a unit; lay on a flat, clean surface.
- (8) Remove the rotor (24), vanes (22), and springs (23) from the cam ring (21) using the ring compressor as directed in subparagraph (5) above.
- (9) Remove the preformed packing (33).
- (10) Using the two 10-24 screws in the tapped holes provided, remove the front port plate (32) from the mounting cap (5); remove the relief fittings (35).
- (11) Remove the wavy washer spring (25) and retaining ring (26) from the mounting cap (5).
- (12) Push the assembled shaft (29) and bearing (27) out of the mounting cap (5).
- (13) Remove the shaft seal (28) by pressing in the back side of the seal from the front of the mounting cap (5). Be certain not to score the seal bore.
- (14) Remove the retaining ring (30) from the shaft (29).
- (15) Remove the ball bearing (27) from

the shaft by pressing on the inner face of the bearing.

- (16) Remove the screws (19) and (20) and remove the center port plate (18). Press the needle bearing (17) out of the center port plate being careful not to damage the bearing bore.
  - (17) Insert a  $\frac{5}{8}$ -11 screw into the tapped hole provided in the center of the rear port plate (37) and remove the rear port plate and spring (39).
  - (18) Remove the preformed packings (13 and 38).
- b. *Cleaning and Inspection.*
- (1) The proper function and performance of these units requires that very close running clearance exist between the port plates, vanes, and cam rings. It is mandatory that all parts be washed thoroughly in cleaning solvent and blown dry with clean compressed air. Dirt is a major cause of wear and pump failure. Cover all parts after cleaning to prevent dust and dirt from settling on them. All surfaces should be coated with a film of hydraulic lubricating oil per MIL-H-5606 after they have been cleaned.
  - (2) Replace all seals.
  - (3) Inspect all springs for cracks or permanent set.
  - (4) Inspect all bearings for wear or flat spots.
  - (5) Inspect cam rings for wear.
  - (6) Inspect the rotors for scores or mar-  
ring on the wear face.
  - (7) Replace all defective parts.
- c. *Reassembly and Installation* (fig. 176).
- (1) Press the bearing (17) into the center port plate (18) with the stamped end of the bearing against the shoulder of the pressing tool. The near end of the bearing should be eleven-sixteenths inch below the face of the center port plate.
  - (2) Insert the center port plate (18) into the center housing (4), aligning the arrow on the suction ports with the large inlet port; secure with screws (19 and 20). Tighten evenly to a torque of 12 to 15 foot-pounds, being careful not to cock the center port plate.



MSC 3805-201-15/176

- |                       |                      |                       |                       |
|-----------------------|----------------------|-----------------------|-----------------------|
| 1 Screw               | 11 Data plate        | 21 Cam ring           | 31 Preformed packing  |
| 2 End cap             | 12 Preformed packing | 22 Vane               | 32 Front port plate   |
| 3 Screw               | 13 Preformed packing | 23 Vane spring        | 33 Preformed packing  |
| 4 Center housing      | 14 Rotor             | 24 Rotor              | 34 Preformed packing  |
| 5 Mounting cap        | 15 Cam ring          | 25 Wavy washer spring | 35 Relief fitting     |
| 6 Spring guide        | 16 Vane              | 26 Retaining ring     | 36 Vane spring        |
| 7 Dowel pin           | 17 Needle bearing    | 27 Ball bearing       | 37 Rear port plate    |
| 8 Spring guide        | 18 Center port plate | 28 Shaft seal         | 38 Preformed packing  |
| 9 Dowel pin           | 19 Screw             | 29 Spline shaft       | 39 Compression spring |
| 10 Self-tapping screw | 20 Screw             | 30 Retaining ring     |                       |

Figure 176. Main hydraulic pump, cross-sectional view.

- (3) Lay the large rotor (24) face down on a clean flat surface. Install the large springs (23) in the openings provided in the rotor.
- (4) Install the spring guides (6) in the springs and place the large vanes (22) carefully over these springs and partially in the rotor slots.
- (5) Place the ring compressor or hose clamps around the rotor (24) and vanes (22). Draw up to compress the vanes into the slots. Carefully insert this assembly in the cam ring (21), using a backup plate to prevent the vanes from sliding endwise in the slots.  
*Note.* Be certain that the assembly is inserted far enough in the cam ring so that when the compressor is removed, the vanes do not fly out of position.
- (6) Insert a dowel pin (7) in the hole provided in the center port plate (18). Use the dowel pin hole nearest the arrow indicating shaft rotation.
- (7) Aline the dowel pin hole in the rear of the cam ring (21) with the installed dowel pin (7). Insert the cam ring (21), vane (22), and rotor (24) into the center housing (4) and against the center port plate (18) with the side marked with the assembler.
- (8) Press the ball bearing (27) on the shaft (29) to the shoulder; install the retaining ring (30) to hold the bearing in place.
- (9) Press the shaft seal (28) into the mounting cap (5). The open face of the seal must be toward the inside of the pump.  
*Note.* Special care must be taken to keep foreign matter from sealing the lips of the seal to prevent cuts or abrasion of these edges.
- (10) Completely fill the space between the seal lips with high-temperature grease. Press the shaft assembly into the mounting cap (5). Apply a protective covering (tape or metal tube) over the spline end of the shaft.
- (11) Insert the retaining ring (26) in the groove against the bearing (27). The retaining ring must be fully seated in the groove.
- (12) Install the preformed packings (31 and 33) in the mounting cap (5).  
  
Place heavy grease on both packings. Install the preformed packing (34) on the front port plate (32). Place heavy grease on the packing.
- (13) Install the relief fittings (35) in the front port plate (32).
- (14) Place the wavy washer spring (25) against the retaining ring (26) and insert the front port plate (32) into the mounting cap (5), taking care not to damage the preformed packings.
- (15) Install the dowel pin (7) in the hole provided in the face of the cam ring (21).
- (16) Aline the cap mounting assembly and center housing assembly. Insert the center housing assembly over the spline shaft (29); engage the shaft splines to the rotor (24) splines; engage the dowel pin (7) in the hole in the front port plate (32), being careful not to disengage the dowel pin.
- (17) Attach the center housing (4) to the mounting cap (5) with the screws (3). Tighten securely and evenly to a torque of 130 foot-pounds, being careful not to cock any internal parts.
- (18) Lay the small rotor (14) face down on a clean flat surface. Install the small spring (36) in the opening provided in the rotor.
- (19) Install the spring guides (8) in the springs; place the vanes (16) carefully over the springs and partially in the rotor slots.
- (20) Place the ring compressor or hose clamps around the rotor and vanes. Draw up to compress the vanes in the slots. Carefully insert this assembly in the cam ring (15), using a backup plate to prevent the vanes from sliding endwise in the slots and damaging the spring. If the vanes slide endwise, inspect and replace any damaged springs.
- (21) Install the dowel pin (9) in the hole provided in the rear of the center port plate (18). Use the dowel pin hole nearest the arrow indicating shaft rotation.
- (22) Aline the dowel pin hole in the rear of the cam ring (15) with the installed dowel pin (9). Insert the cam ring,

vane (16), and rotor (14) into the center housing (4) and against the center port plate (18) with the side marked with an arrow indicating the desired shaft rotation facing the assembler.

- (23) Install the preformed packings (13 and 38) on the rear port plate (37). Place heavy grease on both packings.
- (24) Place the compression spring (39) in the end cap (2). Insert the port plate assembly into the end cap, being careful not to damage the preformed packings.
- (25) Install the dowel pin (9) in the hole provided in the face of the cam ring (15). Install the preformed packings (12) over the end cap projection and against the shoulder. (Place heavy grease on the packings.) Aline the rear port plate assembly and center housing assembly. Insert the rear cap shoulder inside the center housing and engage the dowel pin (9) in the cam ring (15), being careful not to disengage the dowel pin.
- (26) Attach the end cap (2) to the housing (4) with the screws (1). Tighten securely and evenly to a torque of 70 to 80 foot-pounds, being careful not to cock any internal parts.
- (27) Install the hydraulic pump as directed in paragraph 206c.

*d. Testing (fig. 177).*

- (1) Provide a supply of oil with the following specifications for testing the pump:

Oil.....150-300 SSU at 100° F.  
 Viscosity index.....90 or above  
 Minimum running viscosity.....65 SSU  
 Maximum viscosity at starting  
 temperature .....7500 SSU

Oil must also conform to MIL-L-2104A SUP. I specifications.

- (2) Connect the pump (7) to an electric motor (9) with a 100-hp output through a flexible coupling (8). Make sure the relief valves (12) are backed off to provide 0 (zero) psi pressure. Make sure the pump is driven in the direction shown on the nameplate. Provide a test circuit as shown in figure 177.
- (3) Make sure the pump and the oil are at

the same temperature. If necessary, soak the pump in hot oil to heat the pump. Seizing of the pump may occur if the pump and oil are at greatly different temperatures.

- (4) Open the air bleed valve (11) until the pump primes. Alternately press the motor start and stop button to cycle the pump until the pump primes.
- (5) Increase the outlet pressure immediately to 500 psi on both circuits to permit pressure lubrication to the rotors and to prevent seizing.
- (6) Immediately check the flow meter (13) for delivery on both cartridges to see if oil is being delivered. If no oil is being delivered, shut off the motor. Check the housing markings and motor rotation for correct assembly. Check the pump inlet vacuum.
- (7) Run the pump for a minimum of 5 minutes at 2,500 psi on the smaller cartridge section and 2,000 psi on the larger section.
- (8) Maintain the oil temperature at 145° to 155° F. on 150 SSU oil.
- (9) Check deliveries at maximum rated rpm and at 0, 500, 1000, 1500, 2000, and 2500 psi on the smaller section and 0, 500, 1000, 1500, and 2000 psi on the larger section. Deliveries should exceed the minimum values given below:

*LARGER SECTION*

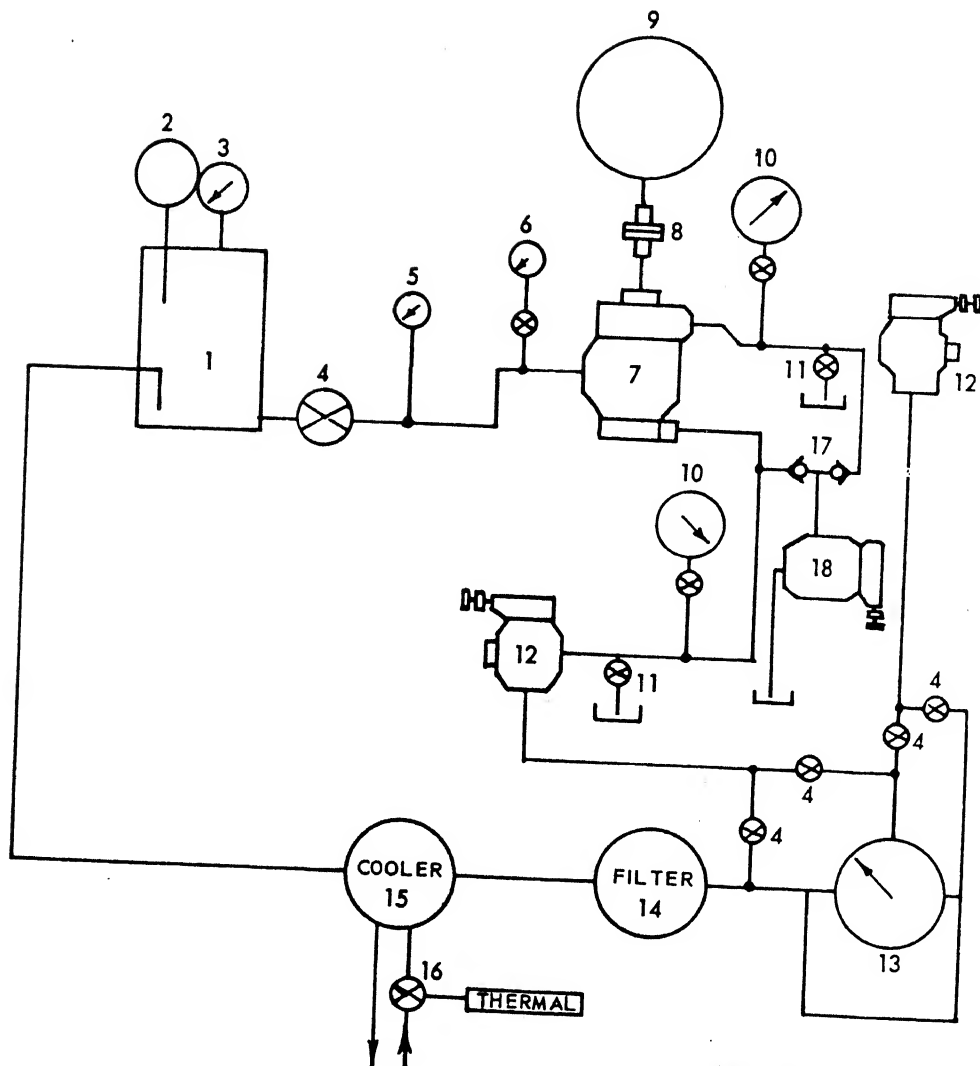
Speed and pressure	Delivery (gpm)
1200 rpm 100 psi	35.0
2100 rpm 2000 psi	61.0

*SMALL SECTION*

Speed and pressure	Delivery (gpm)
1200 rpm 100 psi	8
2100 rpm 2500 psi	11.5

- (10) Inspect the shaft seal and housing for oil or air leaks.
- (11) Check the pump noise level. If the pump is noisy, check the shaft seal for





MSC 3805-201-15/177

- |  |                                  |                                   |  |
|--|----------------------------------|-----------------------------------|--|
| 1 Reservoir  | 6 Vacuum gage (0-30 in. hg)      | 11 Air bleed valve                | 15 Cooler                                |
| 2 Air filter   | 7 Pump to be tested              | 12 Relief valve (0 to 3000 psi)   | 16 Water valve with thermostatic control |
| 3 Oil volume gage                                    | 8 Flexible coupling              | 13 Flow meter with inlet strainer | 17 Check valve                           |
| 4 Gate valve   | 9 Electric motor                 | 14 Oil filter                     | 18 Relief valve (0 to 5000 psi)          |
| 5 Oil temperature gage (Should not restrict suction) | 10 Pressure gage (0 to 4000 psi) |                                   |  |

Figure 177. Hydraulic pump, test setup.

correct installation and the suction line joints for air leaks.  
(12) If acceptable, remove from the stand. Drain the housing.

## 247. Hydraulic Control Valve (fig. 178)

### a. Removal and Disassembly.

- (1) Remove the hydraulic control valve as directed in paragraph 207b. Clean all dirt from the exterior of the valve.

- (2) Remove the plug (29) from the valve housing (28) and remove the preformed packing (30) from the plug. Remove the four plugs (38), springs (39), and poppets (40) from the valve housing and remove the preformed packing (5) from the plugs.
- (3) Remove the plug (13), spring (12), and poppet (11) from the valve housing. Remove the preformed packing (5) from the plug. Remove the backup

- ring (8) and the preformed packing (9) from the poppet.
- (4) Remove the capnut (1), locknut (37), plug (4), and adjusting plug (3) from the valve housing. Remove the preformed packing (5) from the plug.
  - (5) Remove the adjusting screw (2) from the sleeve (10), noting how many turns are necessary to unscrew it. Remove the spring (6) and poppet (7) from the sleeve.
  - (6) Do not remove the sleeve unless visual inspection indicates that it must be replaced. If replacement is necessary, place a soft drift at the narrow end of the sleeve (the end which receives the adjusting screw) and push the sleeve from the valve housing with a press.
  - (7) Remove the plug (49), shims (50), spring (51), and poppet (53) from the cap (47). Remove the washer (48) from the plug. Remove the cap (47) from the relief valve housing (52). Remove the preformed packings (43 and 45) and the backup ring (46) from the cap.
  - (8) Remove the sleeve (44) from the relief valve housing. Remove the spring (54) and poppet (55) from the sleeve. Remove the backup ring (41), preformed packing (42), and poppet (56) from the poppet (55).
  - (9) Remove the relief valve housing (52) from the control valve housing. Remove the preformed packing (43) from the relief valve housing. Remove and disassemble the second relief valve.
  - (10) Remove the pin (18) that secures the plunger pin (23) to the cap (19). Remove the two capscrews (27) that secure the cap to the control valve housing; remove the cap.
  - (11) Carefully slide the assembled plunger (35) and plunger pin from the control valve housing. Pull the plunger pin from the plunger end (24), being careful not to lose the balls (21 and 22). Remove the balls and spring (25) from the plunger pin.
  - (12) Remove the plunger end from the plunger and disassemble the spring

(26) and two seats (20). Remove the two screws (32), the plate (31), wiper (34), and support ring (33).

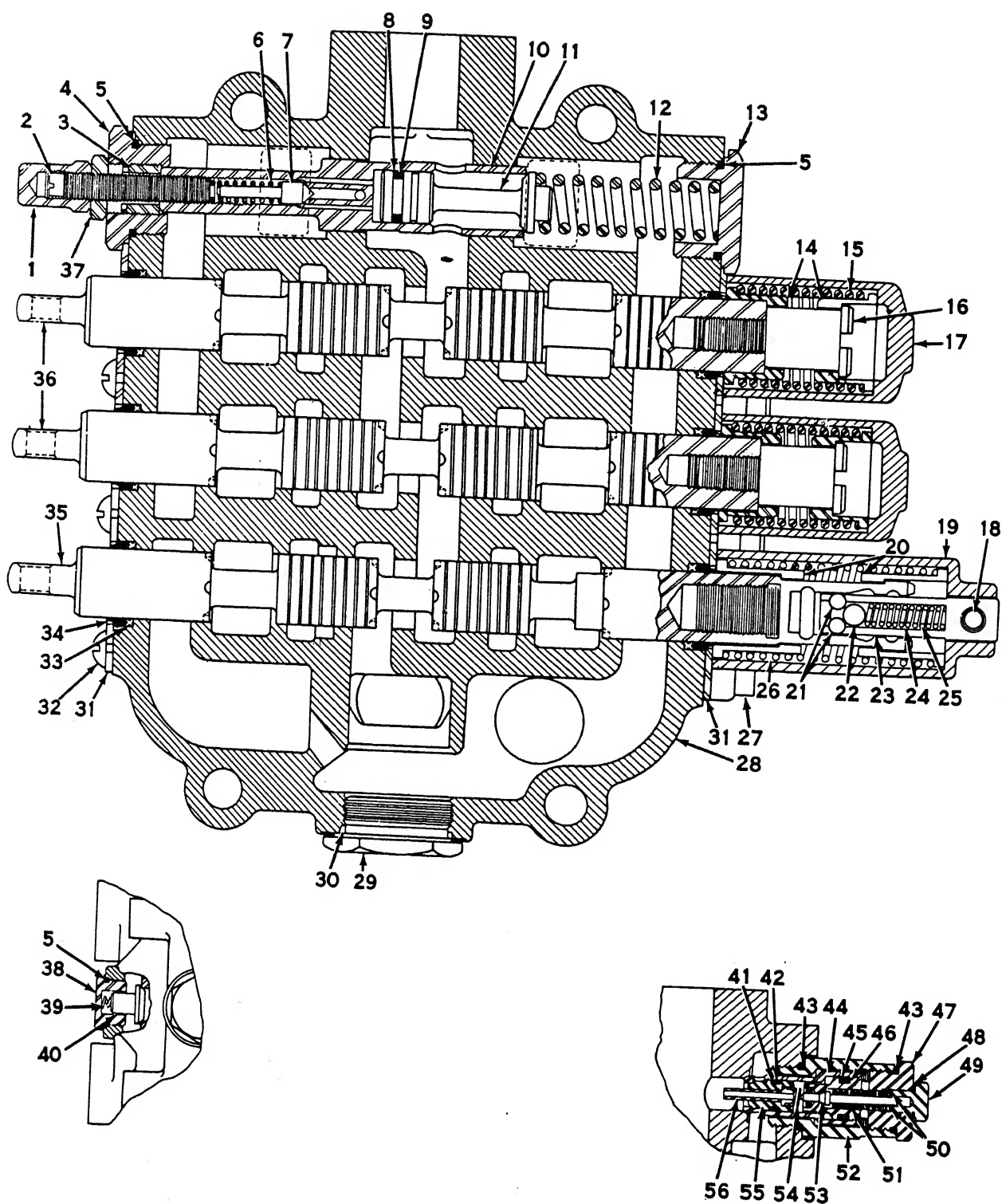
- (13) Remove the capscrews (27) that secure a cap (17) to the valve housing; remove the cap. Carefully slide the assembled plunger (36) from the control valve housing. Remove the shoulder screw (16) from the plunger and disassemble the spring (15) and the seats (14).

*Note.* The plungers must be reinstalled in the holes from which they were removed. Tag the plungers to assure proper reassembly.

- (14) Remove the two screws (32) that secure the plate (31) to the control valve housing. Remove the plate (31), wiper (34), and support ring (33).
- (15) Remove the remaining plunger from the housing and disassemble as directed in subparagraph (13) above. Remove the plate, wiper, and support ring.

*b. Cleaning and Inspection.*

- (1) Clean all metallic parts by washing with an approved cleaning solvent; dry with clean, dry compressed air. Lightly coat all reusable parts with clean hydraulic fluid.
- (2) Inspect all parts for cracks, corrosion, or other damage.
- (3) Inspect the plungers and the plunger bores in the housing for grooves, nicks or deep scratches, pitting, or excessive wear. Check that the plungers fit their respective bores with a slight hand pressure and without perceptible side clearance. If the plungers are loose, scored, or damaged, or if the housing has damaged threads, cracks, or scored bores, replace the control valve with a new unit.
- (4) Inspect the check valve poppets and their seating faces in the housing for grooves or excessive wear.
- (5) Inspect the relief valve sleeves and poppets for scoring or excessive wear.
- (6) Inspect the springs for cracks, distortion, or loss of tension.
- (7) Replace all preformed packings, wipers, support rings, and all unserviceable parts.



MSC 3805-201-15/178

Figure 178. Hydraulic control valve, cross-sectional view.

1 Capnut	15 Spring	29 Plug	43 Preformed packing
2 Adjusting screw	16 Shoulder screw	30 Preformed packing	44 Sleeve
3 Adjusting plug	17 Cap	31 Plate	45 Preformed packing
4 Plug	18 Pin	32 Screw	46 Backup ring
5 Preformed packing	19 Cap	33 Support ring	47 Cap
6 Spring	20 Seat	34 Wiper	48 Washer
7 Poppet	21 Ball	35 Plunger	49 Plug
8 Backup ring	22 Ball	36 Plunger	50 Shim
9 Preformed packing	23 Plunger pin	37 Locknut	51 Spring
10 Sleeve	24 Plunger end	38 Plug	52 Relief valve housing
11 Poppet	25 Spring	39 Spring	53 Poppet
12 Spring	26 Spring	40 Poppet	54 Spring
13 Plug	27 Capscrew	41 Backup ring	55 Poppet
14 Seat	28 Housing	42 Preformed packing	56 Poppet

Figure 178—Continued.

### c. Reassembly and Installation.

*Note.* Lubricate all working parts of the hydraulic control valve with clean hydraulic fluid before reassembly.

- (1) If the sleeve (10) was removed during disassembly, press a new sleeve into the control valve housing (28) to the position shown in figure 178.
- (2) Install the preformed packing (5) on the plug (4) and screw the plug into the valve housing. Install the adjusting plug (3) in the plug (4) and seat against the small end of the sleeve.
- (3) Place the poppet (7) and spring (6) in the sleeve. Install the adjusting screw (2), turning approximately as many turns as were necessary to remove it. Install the locknut (37) and capnut (1).
- (4) Install the backup ring (8) and preformed packing (9) on the poppet (11) and install the poppet in the sleeve. Place the spring (12) in the housing so that it engages the poppet. Install the preformed packing (5) on the plug (13); install the plug.
- (5) Install a preformed packing (5) on each of the four plugs (38). Install the four poppets (40), four springs (39), and four plugs (38). Place the preformed packing (30) on the plug (29); install the plug.
- (6) Install the backup ring (41) and the preformed packing (42) on the poppet (55); install the smaller poppet (56) in the larger poppet (55). Install the poppet assembly in the sleeve (44) and place the sleeve in the relief valve housing (52).
- (7) Install the preformed packings (43 and 45) and backup ring (46) on the cap (47). Place the poppet (53) and the spring (51) in the cap. Add shims (50) of the same thickness as those removed. Install the washer (48) on the plug (49) and screw the plug into the cap.
- (8) Install the spring (54) on the poppet (55). Screw the assembled cap into the relief valve housing (52). Install the preformed packing (43) on the relief valve housing and install the relief valve housing on the control valve housing. Take care that the spring is properly positioned between the poppets. Assemble and install the remaining relief valve.
- (9) Carefully slide the plunger (35) into the control valve housing. Install a support ring (33) and wiper (34) in the housing recesses at each end of the plunger. Install a plate (31) at each end of the plunger.
- (10) Install a seat (20) on the plunger and install the spring (26) over the seat. Install the second seat in the spring and secure to the plunger with the plunger end (24).
- (11) Install the spring (25) and large ball (22) in the plunger pin (23). Depress the spring and ball and install the small balls (21) in their holes in the plunger pin. Push the assembled plunger pin into the plunger end.
- (12) Place the cap (19) over the end of the plunger and install the pin (18) through the plunger pin and cap. Secure the cap and plate (31) to the control valve housing with the capscrews (27). Secure the plate (31) at the opposite end of the plunger with the two screws (32).

- (13) Install a plunger (36) in the plunger bore from which it was removed. Install a support ring and wiper in the recesses in the housing at each end of the plunger. Install a plate (31) at each end of the plunger.
- (14) Install a seat (14) over the installed plunger. Install the spring (15) over the seat and install the second seat in the spring. Secure the seats and spring to the plunger with the shoulder screw (16).
- (15) Install a cap (17) over the end of the plunger and secure the cap and plate (31) to the control valve housing with the capscrews (27). Secure the plate (31) at the opposite end of the plunger with the screws (32). Assemble and install the remaining plunger.
- (16) Install the hydraulic control valve as outlined in paragraph 207d.

#### **248. Boom Cylinders** (fig. 179)

##### *a. Removal and Disassembly.*

- (1) Remove the boom cylinders as directed in paragraph 208a. Clean all dirt from the exterior of the cylinders.
- (2) Remove the two nuts (10), lockwashers (2), and capscrews (3) that secure the piston rod end (12) to the piston and rod assembly (28). Remove the piston rod end. Remove the bushing (11) from the piston rod end if excessively worn.
- (3) Remove the three capscrews (8) and lockwashers (7) that secure the end cap (4) to the cylinder cap (5). Remove the wiper retainer (6) and end cap from the cylinder (24). Remove the wiper (13) and wiper gasket (14) from the end cap and remove the cylinder cap gasket (15) from the cylinder cap.
- (4) Push the cylinder cap (5) into the cylinder and remove the lockring (16) from the cylinder. Pull the assembled piston and piston rod and the assembled cylinder cap from the cylinder.
- (5) Pull the assembled cylinder cap from the piston rod. Remove the two retaining rings (27), two piston packings

(29), wear ring (25), and lockring (26) from the piston.

- (6) Remove the retaining ring (23), backup ring (22), gland ring (21), eight packing gland springs (20), and piston rod packing (17) from the cylinder cap bore. Remove the backup washer (18) and preformed packing (19) from the cylinder cap.
- (7) If excessively worn, remove the bushing (9) from the cylinder cap. Remove the lubrication fitting (10) from the piston rod end.

##### *b. Cleaning and Inspection.*

- (1) Clean all metallic parts by washing with an approved solvent; dry with clean, dry compressed air. Lightly coat the piston rod and the interior of the cylinder with clean hydraulic fluid.
- (2) Inspect the piston and rod assembly for scoring, nicks, cracks, pitting, distortion, or excessive wear.
- (3) Inspect the cylinder for cracks, pitted areas, scoring, or other damage.
- (4) Inspect the cylinder cap, end cap, and piston rod end for cracks, stripped threads, or other defects.
- (5) Replace the wiper, wear ring, all packings, and all defective or excessively worn parts.

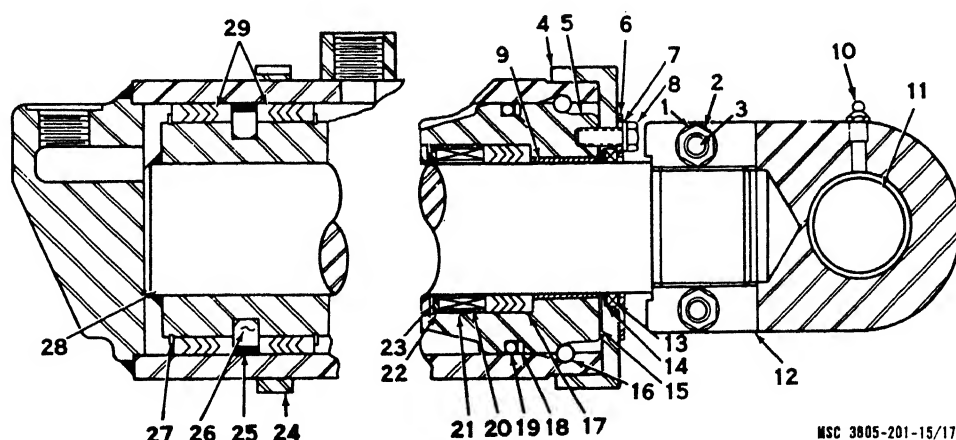
##### *c. Reassembly and Installation.*

- (1) Reassemble the boom cylinders by reversing the disassembly procedure given in subparagraph *a* above. If replaced, ream the piston rod end bushing (11) to 2.002 to 2.004 inches. Tighten the rod end capscrews (3) and nuts (1) to a torque of 165 foot-pounds. Tighten the end cap capscrews (8) to a torque of 35 foot-pounds.
- (2) Install the boom cylinders as directed in paragraph 208c.

#### **249. Bucket Cylinder** (fig. 180)

##### *a. Removal and Disassembly.*

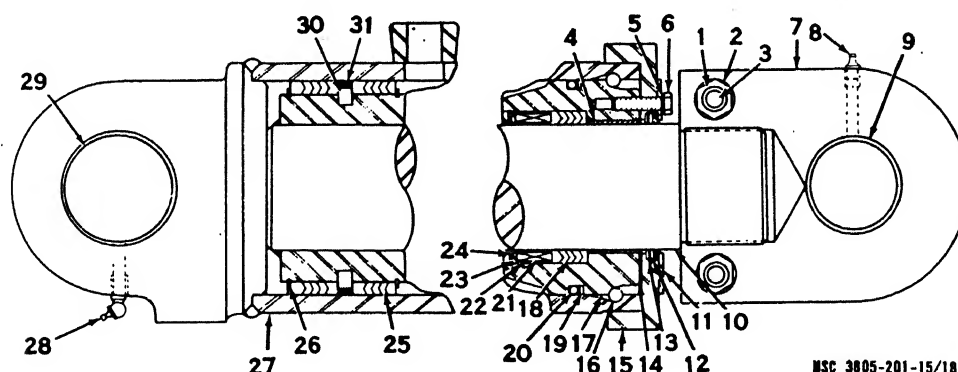
- (1) Remove the bucket cylinder as directed in paragraph 209a. Clean all dirt from the exterior of the cylinder.
- (2) Remove the two nuts (1), lockwashers (2), and capscrews (3) from the piston rod end (7). Remove the piston



MSC 3805-201-15/179

- |                  |                        |                         |                            |
|------------------|------------------------|-------------------------|----------------------------|
| 1 Nut            | 9 Bushing              | 17 Piston rod packing   | 24 Cylinder                |
| 2 Lockwasher     | 10 Lubrication fitting | 18 Backup washer        | 25 Wear ring               |
| 3 Capscrew       | 11 Bushing             | 19 Preformed packing    | 26 Lockring                |
| 4 End cap        | 12 Piston rod end      | 20 Packing gland spring | 27 Retaining ring          |
| 5 Cylinder cap   | 13 Wiper               | 21 Gland ring           | 28 Piston and rod assembly |
| 6 Wiper retainer | 14 Wiper gasket        | 22 Backup ring          | 29 Piston packing          |
| 7 Lockwasher     | 15 Cylinder cap gasket | 23 Retaining ring       |                            |
| 8 Capscrew       | 16 Lockring            |                         |                            |

Figure 179. Boom cylinders, cross-sectional view.



MSC 3805-201-15/180

- |                       |                            |                         |                        |
|-----------------------|----------------------------|-------------------------|------------------------|
| 1 Nut                 | 9 Bushing                  | 16 Lockring             | 24 Retaining ring      |
| 2 Lockwasher          | 10 Piston and rod assembly | 17 Cylinder cap         | 25 Piston packing      |
| 3 Capscrew            | 11 Wiper retainer          | 18 Piston rod packing   | 26 Retaining ring      |
| 4 Bushing             | 12 Wiper                   | 19 Backup washer        | 27 Cylinder            |
| 5 Lockwasher          | 13 Wiper gasket            | 20 Preformed packing    | 28 Lubrication fitting |
| 6 Capscrew            | 14 Cylinder cap gasket     | 21 Packing gland spring | 29 Bushing             |
| 7 Piston rod end      | 15 End cap                 | 22 Gland ring           | 30 Lockring            |
| 8 Lubrication fitting |                            | 23 Backup ring          | 31 Wear ring           |

Figure 180. Bucket cylinder, cross-sectional view.

rod end from the piston and rod assembly (10).

- (3) Remove the three capscrews (6) and lockwashers (5) that secure the end cap (15) to the cylinder cap (17). Remove the wiper retainer (11) and the end cap from the cylinder.
- (4) Remove the wiper (12) and the wiper gasket (13) from the end cap. Re-

move the cylinder cap gasket (14) from the cylinder cap.

- (5) Push the assembled cylinder cap into the cylinder and remove the lockring (16). Pull the assembled cylinder cap and the assembled piston and rod assembly from the cylinder.
- (6) Remove the assembled cylinder cap from the piston rod. Remove the two

retaining rings (26), two piston packings (25), wear ring (31), and locking ring (30) from the piston.

(7) Remove the retaining ring (24), backup ring (23), gland ring (22), eight packing gland springs (21), and piston rod packing (18) from the bore of the cylinder cap. Remove the backup washer (19) and the preformed packing (20) from the cylinder cap.

(8) If excessively worn, press the bushing (4) from the cylinder cap, the bushings (9) from the piston rod end, and the bushings (29) from the cylinder end. Remove the lubrication fittings (8 and 28) from the piston rod end and the cylinder end.

*b. Cleaning and Inspection.*

(1) Clean all metallic parts by washing with an approved solvent; dry with clean, dry compressed air. Lightly coat the piston and rod assembly and the interior of the cylinder with clean hydraulic fluid.

(2) Inspect the piston and rod assembly for scoring, pitting, distortion, cracks, nicks, excessive wear, or stripped threads.

(3) Inspect the cylinder for cracks, dents, pitted areas, scoring, or other damage.

(4) Inspect the cylinder cap, the end cap, and the piston rod end for cracks, stripped threads, or other defects.

(5) Replace the wear ring, wiper, preformed packings, and all defective or excessively worn parts.

*c. Reassembly and Installation.*

(1) Reassemble the bucket cylinder by reversing the disassembly procedure given in *a* above. Tighten the piston rod end capscrews (3) and nuts (1) to a torque of 165 foot-pounds. Tighten the end cap capscrews (6) to a torque of 35 foot-pounds. If replacement bushings were installed, ream the piston rod end bushings (9) to 2.500 to 2.5045 inches and the cylinder end bushings (29) to 3.002 to 3.004 inches.

(2) Install the bucket cylinder as directed in paragraph 209c.

## 250. Clam Cylinders (fig. 181)

*a. Removal and Disassembly.*

(1) Remove the clam cylinders as directed in paragraph 219b. Clean all dirt from the exterior of the cylinders.

(2) Unscrew the cylinder head (14) from the cylinder assembly (8) and remove the preformed packing (13) from the cylinder head. Pull the assembled piston rod (7) and piston (2) from the cylinder.

(3) Remove the nut (1), piston (2), packing retainer (6), and preformed packing (5) from the piston rod. Remove the wear ring (3) and packing (4) from the piston. Pull the assembled cylinder head off the piston rod.

(4) Remove the two nuts (16) that secure the packing flange (15) to the cylinder head. Remove the packing flange and the packing (12) from the cylinder head. Remove the wiper (18) from the packing flange. If damaged, remove the two studs (17) from the cylinder head.

(5) If excessively worn, press the bushing (20) from the end of the piston rod. Remove the lubrication fitting (19) from the end of the piston rod.

*b. Cleaning and Inspection.*

(1) Thoroughly clean all metallic parts by washing with an approved solvent; dry with compressed air. Coat the piston rod and the interior of the cylinder with clean hydraulic fluid.

(2) Wipe the remaining parts with a clean cloth.

(3) Inspect the parts for cracks, stripped threads, pitting, corrosion, or other damage.

(4) Inspect the piston rod and cylinder for scoring, nicks, distortion, excessive wear, or other damage.

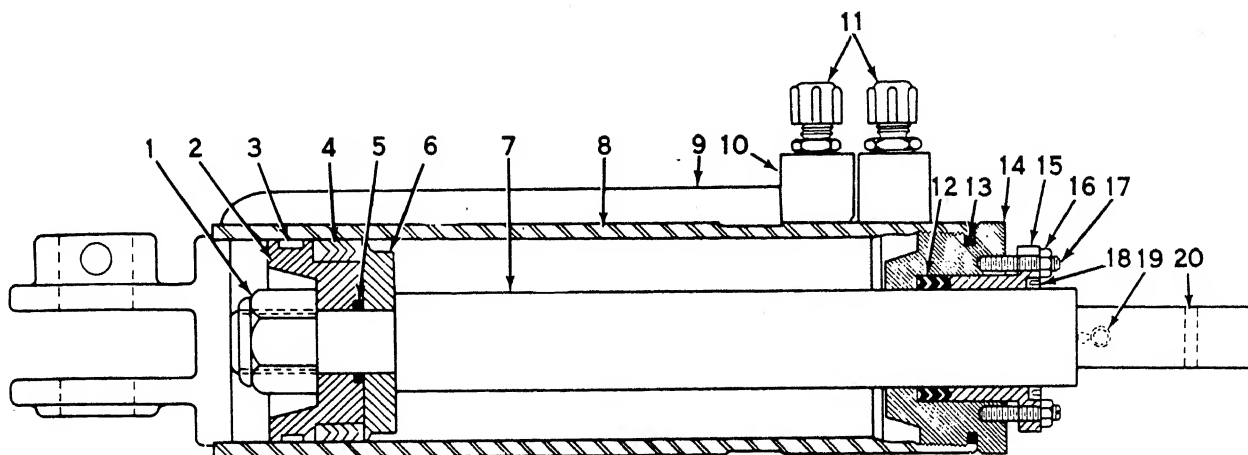
(5) Replace the wiper, packings, and all unserviceable parts.

*c. Reassembly and Installation.*

(1) Reassemble the clam cylinders by reversing the disassembly procedure given in subparagraph *a* above.

(2) Install the clam cylinders as directed in paragraph 219d.





MSC 3805-201-15/181

1 Nut	6 Packing retainer	11 Capnut	16 Nut
2 Piston	7 Piston rod	12 Packing	17 Stud
3 Wear ring	8 Cylinder	13 Preformed packing	18 Wiper
4 Packing	9 Tube assembly	14 Cylinder head	19 Lubrication fitting
5 Preformed packing	10 Connector assembly	15 Packing flange	20 Bushing

Figure 181. Clam cylinder, cross-sectional view.

## 251. Hydraulic Reservoir (fig. 98)

### a. Removal and Disassembly.

- (1) Drain the hydraulic system as directed in paragraph 204b. Disconnect the two hydraulic hoses leading to the reservoir and remove the four cap-screws, nuts, and lockwashers that secure the reservoir to the hydraulic manifold.
- (2) Loosen the coupling (23) and remove the top (1) from the reservoir. Remove the preformed packing (22) from the coupling. Remove the three nuts (5) and lockwashers (4) that secure the flange (6) to the studs (15). Remove the flange and spring (7) and lift out the filter (19).
- (3) Remove the dipstick oil gage (3), dipstick seal (2), filter strainer (21), breather filter assembly (8), vacuum breaker (9), and check valve (10) from the top.
- (4) Unscrew the three studs (15) from the reservoir bottom (20). Remove

the coupling (13), filter manifold (14), screen (12), and sediment trap (18) from the reservoir bottom.

### b. Cleaning and Inspection.

- (1) Clean all metallic parts with an approved solvent and dry with compressed air. Wipe other parts with a clean cloth.
- (2) Inspect the filler strainer, screen, and sediment trap for clogging or distortion.
- (3) Check the breather filter assembly, vacuum breaker, check valve, and hose for cracks, breaks, and stripped threads. Check the action of the check valve.
- (4) Inspect the nuts, studs, and drain plug for stripped threads.
- (5) Replace the drain plug preformed packing, dipstick seal, and all other damaged or unserviceable parts.

c. *Reassembly and Installation.* Reassemble and install the hydraulic reservoir by reversing the removal and disassembly procedure given in a above.

## Section VII. AIR SYSTEM

### 252. Description

a. *General.* Air to pressurize the air system is derived from the air compressor mounted on

and gear-driven by the engine. The air is stored in the air reservoir until it is needed to operate the power cluster (under control of the foot

treadle valve), the air horn (under control of the electrically operated air valve on the horn), the low air pressure warning buzzer (under control of the low air pressure switch), and the service coupling for trailer brake operation (under control of the hand brake valve or the brake treadle valve). Air pressure from the reservoir is supplied constantly to the emergency brake coupling and to the air pressure gage.

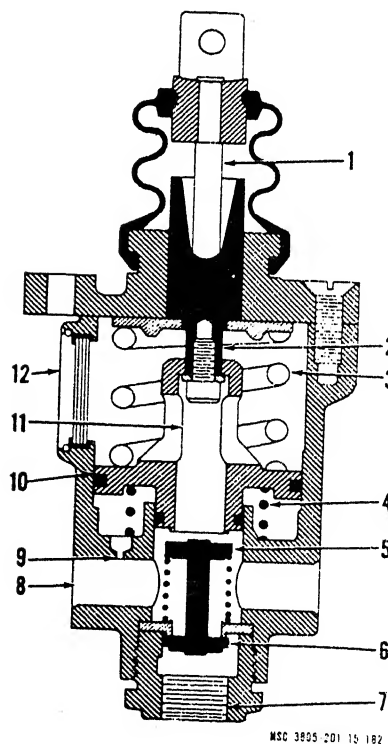
*b. Air Compressor.*

- (1) The air compressor is a single-acting, reciprocating, one-cylinder type that is flange-mounted on the gear case and gear-driven at engine speed by the engine crankshaft gear train. The compressor runs continuously while the engine is running, but the actual compression of air is controlled by the air compressor governor acting in conjunction with the unloader valve in the compressor cylinder head.
- (2) During the downward stroke of the piston, a partial vacuum is created above the piston which pulls the intake valve downward from its seat and allows air to be drawn into the cylinder. As the piston starts its upward stroke, the intake valve closes and the exhaust valve opens; this allows the compressed air to discharge through the line to the air reservoir. When the air pressure in the reservoir reaches 100 to 105 psi, compressed air returns through the air governor into the cavity above the unloader valve in the compressor cylinder head. The air pressure on the unloader valve opens the intake valve to stop further compression of air and allow the air compressor to pump freely. When the reservoir air pressure is reduced to 80 to 85 psi, the unloader valve is released by the air governor, and the air compressor resumes normal operation.
- (3) To provide cooling, coolant from the engine circulates through the air compressor crankcase and cylinder head and returns to the engine thermostat housing. Lubrication is provided by oil from the engine.

*c. Treadle Valve (fig. 182).*

- (1) The treadle valve, mounted on the floor

of the operator's compartment, is operated by the integral foot treadle. Air under pressure is supplied from the reservoir to the inlet port of the valve. When the foot treadle is depressed, the controlling force is transferred through the push rod (1) and metering spring (3) to the piston (10), which moves against the exhaust valve (5) to close the exhaust passage through the piston and to unseat the inlet valve (6). The air thus admitted is directed to the air cylinder of the power cluster and also bypasses through the equalization orifice (9) to build up pressure against the piston, forcing it to move on the stem (2) against the metering spring. When the controlling force is balanced by the applied pressure, the inlet valve closes and the exhaust valve remains seated with the valve in a holding position.



- |                   |                        |
|-------------------|------------------------|
| 1 Push rod        | 7 Inlet port           |
| 2 Stem            | 8 Application ports    |
| 3 Metering spring | 9 Equalization orifice |
| 4 Return spring   | 10 Piston              |
| 5 Exhaust valve   | 11 Exhaust passage     |
| 6 Inlet valve     | 12 Exhaust port        |

Figure 182. Treadle valve, cross-sectional view.

- (2) The treadle valve meters pressures up to 75 psi. Above this pressure, the inlet valve remains open and the full reservoir pressure is applied. When the controlling force is removed from the treadle, the piston return spring (4) unseats the piston from the exhaust valve and the air is exhausted through the exhaust passage (11) of the piston and through the exhaust port (12) of the valve.

*d. Hand brake Valve* (fig. 185). The hand-brake valve is comprised of four major components:

- (1) An air inlet valve (3) that is opened to permit passage of braking air pressure from the air reservoir to apply the brakes of the towed vehicle.
- (2) An air exhaust valve (26) that is opened to permit braking air pressure to exhaust to the atmosphere to release the brakes on the towed vehicle.
- (3) A metering piston (10) that balances pressure developed by movement of the handle, transmitted through an actuating cam and metering spring. Braking air pressure acts on the surface area of the metering piston. It automatically closes the open valve (inlet or exhaust) as pressures equalize, thus providing a holding action.
- (4) A metering spring (13) that directly balances the braking air pressure acting on the metering piston.

*e. Power Cluster.* The power cluster incorporates an air cylinder, hydraulic master cylinder, and piston stroke indicator.

- (1) The air cylinder is actuated by air pressure applied to the surface of its piston and rod assembly to develop mechanical force to stroke the piston of the hydraulic cylinder.
- (2) The hydraulic master cylinder is designed to perform the following functions:
  - (a) Displace fluid in the system to move the brake shoes into contact with the drums.
  - (b) Develop fluid pressure when all shoes contact the drums.
  - (c) Compensate for temperature changes or fluid seepage to maintain

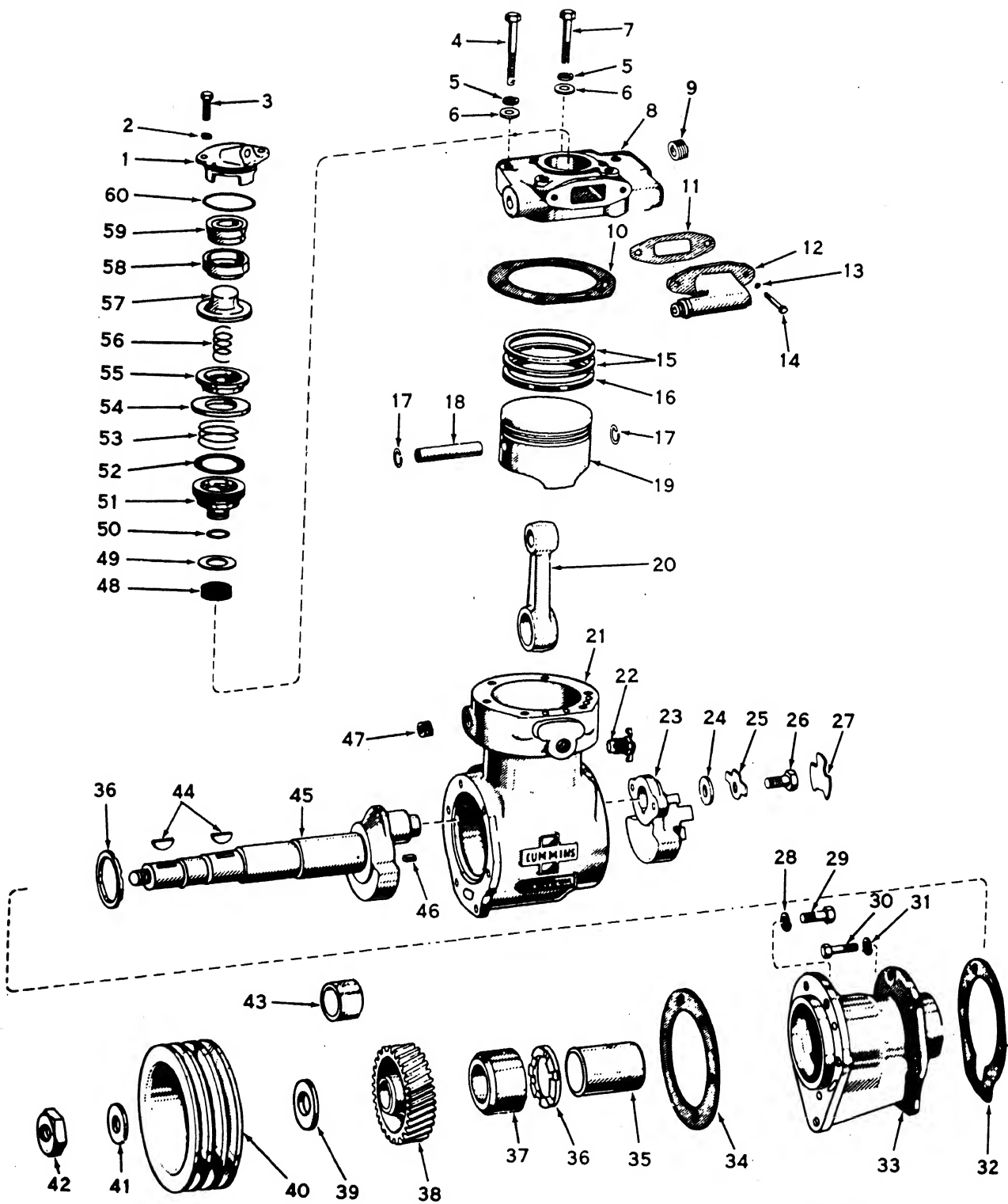
the correct volume of fluid in the sealed system.

- (d) Charge the sealed hydraulic system with fluid upon each release of the brake.
- (3) The piston stroke indicator indicates the piston travel required for brake application to warn of the need for brake lining clearance adjustment.

## 253. Air Compressor (fig. 183)

### *a. Removal and Disassembly.*

- (1) Remove the air compressor from the engine as directed in paragraph 195a.
- (2) Remove the nut (42) and flat washer (41) that secure the pulley (40) to the crankshaft (45). Use a puller and remove the pulley, roller bearing (43), spacer (39), and accessory drive gear (38) from the crankshaft.
- (3) Remove the coupling retainer plate (27). Bend the lockplate (25) to release the capscrew (26). Remove the screw, lockplate, and washer (24) that secure the counterweight (23) to the crankshaft.
- (4) Reinstall the capscrew (26) and use a puller to remove the counterweight; remove the key (46) and capscrew (26).
- (5) Remove the six capscrews (30) and lockwashers (31) that secure the support (33) to the crankcase. Loosen the support by tapping with a soft-faced mallet; remove the assembled support and crankshaft (proceed carefully to prevent damage to the connecting rod bushing) and gasket (32).
- (6) Press the crankshaft (45) from the support; remove the thrust sleeve (37) and thrust bearing (36) from the support, and the thrust bearing from the crankshaft.
- (7) If damaged or excessively worn, press the bushings (35) from the support.
- (8) Remove the four capscrews (4), two capscrews (7), six lockwashers (5), and six flat washers (6) that secure the cylinder head (8) to the crankcase; remove the cylinder head and gasket (10).



MSC 3805-201-15/183

Figure 183. Air compressor, exploded view.

1	Unloader valve body	17	Retaining ring	31	Lockwasher	46	Key
2	Lockwasher	18	Piston pin	32	Gasket	47	Plug
3	Capscrew	19	Piston	33	Support	48	Spring
4	Capscrew	20	Connecting rod	34	Gasket	49	Exhaust valve
5	Lockwasher	21	Crankcase	35	Bushing	50	Preformed packing
6	Flat washer	22	Drain cock	36	Thrust bearing	51	Exhaust valve seat
7	Capscrew	23	Counterweight	37	Thrust sleeve	52	Preformed packing
8	Cylinder head	24	Washer	38	Accessory drive gear	53	Spring
9	Plug	25	Lockplate	39	Spacer	54	Intake valve
10	Gasket	26	Capscrew	40	Pulley	55	Intake valve seat
11	Gasket	27	Coupling retainer plate	41	Flat washer	56	Unloader valve spring
12	Air inlet connection	28	Lockwasher	42	Nut	57	Unloader cap
13	Lockwasher	29	Capscrew	43	Roller bearing	58	Unloader cap guide
14	Capscrew	30	Capscrew	44	Key	59	Unloader seat
15	Piston ring			45	Crankshaft	60	Preformed packing
16	Piston ring						

Figure 133—Continued.

- (9) Remove the two capscrews (14) and lockwashers (13) that secure the air inlet connection (12) to the cylinder head; remove the air inlet connection elbow and gasket (11).
  - (10) Remove the two capscrews (3) and lockwashers (2) that secure the unloader valve body (1) to the cylinder head; use two screwdrivers to pry the body loose; be careful to prevent damage to the parts. Remove the unloader valve body; remove the preformed packing (60) from its groove.
  - (11) Remove the unloader valve spring (56), unloader cap (57), and unloader cap guide (58) from the unloader body. Remove the unloader seat (59) and preformed packing (60) from the body.
  - (12) Remove the intake valve seat (55) from the cylinder head with a needle-nosed pliers.
  - (13) Remove the intake valve (54) and spring (53) with a magnet.
  - (14) Turn the cylinder head cover and press the exhaust valve seat (51) out with thumb pressure; remove the spring (48), exhaust valve (49), and exhaust valve seat (51).
  - (15) Remove the preformed packings (50 and 52) from the exhaust valve seat.
  - (16) Remove the plug (9) from the cylinder head.
  - (17) Push the assembled piston and connecting rod upward from the crankcase.
  - (18) Remove the two compression rings (15) and oil ring (16) from the piston (19). Remove the two retaining rings (17); push the pin (18) from the piston.
  - (10) If excessively worn or damaged, press the bushings from the connecting rod.
  - (20) Remove the two plugs (47) and drain cock (22) from the crankcase.
- b. Cleaning and Inspection.*
- (1) Remove carbon and dirt from the air passages in the cylinder head, and rust and scale from the water cavities in the cylinder head and crankcase. Scrape dirt and particles of old gaskets from all surfaces, taking care not to scratch machined areas.
  - (2) Thoroughly clean all parts by washing with an approved cleaning solvent; dry with compressed air.
  - (3) Clean all oil passages in the crankshaft, crankcase, and support. If necessary, probe the oil passages with a wire; flush with cleaning solvent.
  - (4) Clean the valves that are not damaged or excessively worn by lapping them on a piece of crocus cloth on a flat surface.
  - (5) Inspect the cylinder head for cracks, breaks, stripped threads, or other damage.
  - (6) Inspect the exhaust valve seat for wear or damage. Replace the exhaust valve seat if worn to less than 0.485 inch in height as measured from the shoulder to the top of the seat.
  - (7) Inspect the intake valve seat for cracks, excessive wear, or damage. Replace the intake valve seat if worn to less than 0.270 inch in height as measured from the shoulder to the top of the seat.

- (8) Check the seal seat area of the unloader cap. Replace the cap if the area is not smooth.
- (9) Inspect the crankcase for cracks, breaks, stripped threads, or other damage. Inspect the cylinder bore for scoring, out-of-round, or excessive wear; the cylinder bore must be honed over-size if scored, out-of-round more than 0.0015 inch, or worn to more than 3.433-inch inside diameter.
- (10) Inspect the piston for scoring, cracks, wear to less than 3.433-inch outside diameter measured 1 inch below and at right angles to the pin bore, or excessive ring groove wear. Place the piston ring in the cylinder bore to measure the ring gap; ring gap should be from 0.010 to 0.026 inch.
- (11) Inspect the connecting rod for cracks, distortion, or wear. Replace if the piston pin bushing is worn to more than 0.6895-inch inside diameter or if the crankshaft bushing is worn to more than 1.3787 inches.
- (12) Inspect the crankshaft for scoring, damaged keyways, stripped threads, or out-of-round to more than 0.001 inch.
- (13) Inspect the support for cracks, scoring, or wear of the bushings to more than 1.7555-inch inside diameter, or other damage. If required, install the two bushings (35) on the support (33).
- (14) Replace the intake valve, exhaust valve, all preformed packings, gaskets, and excessively worn or damaged parts.

*c. Reassembly and Installation.*

- (1) Use the proper combination of two thrust bearings (36) by referring to the following thrust bearing chart. The numbers of the crankshaft (45) and support (33) are stamped into the part. Follow the horizontal column under the crankshaft number until it intersects the vertical column of the support number. The letter combination at the point of intersection gives the codes letters of the bearings required. Decode by referring to the

lower portion of the chart designated  
**REQUIRED THRUST BEARINGS.**

SUPPORT NUMBER	Crankshaft Number							
	40	39	38	37	13	12	11	10
53-----	AB	AB	AA	AA				
52-----	BB	AB	AB	AA				
51-----	AC	BB	AB	AB				
50-----	BC	AC	BB	AB				
49-----	BC	BC	AC	BB				
48-----	CC	BC	BC	AC				
26-----					AB	AB	AA	AA
25-----					BB	AB	AB	AA
24-----					AC	BB	AB	AB
23-----					BC	AC	BB	AB
22-----					BC	BC	AC	BB
21-----					CC	BC	BC	AC

Required Thrust Bearings		
Thrust bearing	Size	Chart code letter
No. 130080-----	0.088-0.090-----	A
No. 130081-----	0.090-0.092-----	B
No. 130083-----	0.092-0.094-----	C

- (2) Aline the tang of the thrust bearing (36) with the slot of the support and position with the grooved side out; apply lubriplate to the thrust bearing and install the crankshaft.
- (3) Position the second thrust bearing over the crankshaft with the grooved side out and coated with lubriplate; engage the tang of the thrust bearing with the support. Press the thrust sleeve (37) into position flush with the crankshaft shoulder; check the crankshaft end play which, when measured with the indicator, should be 0.004 to 0.009 inch.
- (4) Position the key (44) on the crankshaft; aline the accessory drive gear (38) with the key and press into place.
- (5) Position the spacer (39) next to the drive gear; press the roller bearing (43) onto the crankshaft.
- (6) Heat the piston (19); aline the assembled connecting rod and bushings with the hole through the piston. Install the pin (18); secure with the two retaining rings (17).
- (7) Install the oil ring (16) and two compression rings (15) on the piston. Observe the top markings and stagger the gaps of the compression rings.

*Note.* Lubricate the piston, piston rings,

pin, connecting rod bushings, and crankcase bore with clean lubricating oil before installing.

- (8) Install the assembled piston and connecting rod from the top of the crankcase, using a ring compressor to compress the piston rings.
- (9) Position the gasket (32) on the crankcase. Install the assembled crankshaft and support on the crankcase, taking care to align the connecting rod and slide it on the crankshaft; secure with the six capscrews (30) and lockwashers (31).
- (10) Position the key (46) and counterweight (23) on the crankshaft; press flush with the crankshaft shoulder. Install the washer (24), lockplate (25), and capscrew (26); tighten the screw to a torque of 40 foot-pounds. With an indicator, check for the required connecting rod side clearance of 0.003 to 0.008 inch; lock the screw with the lockplate.
- (11) Position the exhaust valve (49) on the exhaust valve seat (51); lubricate and install the preformed packings (50 and 52) on the exhaust valve seat.
- (12) Position the spring (48) and the assembled exhaust valve and seat on the cylinder head (8); apply pressure with the thumbs to seat the exhaust valve.
- (13) Position the spring (53), intake valve (54), with lapped surface up, and intake valve seat (55) in the cylinder head.
- (14) Assemble the unloader seat (59), unloader cap guide (58), unloader cap (57), and spring (56) in the unloader valve body (1).
- (15) Lubricate and install the preformed packing (60) on the valve body.
- (16) Install the valve body on the cylinder head; secure with the two capscrews (3) and lockwashers (2), tightening the screws evenly and alternately.
- (17) Position the gasket (11) and air inlet connection (12) on the cylinder head; secure with the two capscrews (14) and lockwashers (13).
- (18) Position the gasket (10) and assembled cylinder head on the crankcase; secure with the four capscrews (4),

two capscrews (7), six lockwashers (5), and flat washers (6). Tighten the screws evenly and alternately to a torque of 35 foot-pounds.

- (19) Install the two plugs (47) and drain cock (22) on the crankcase; install the plug (9) on the cylinder head.
- (20) Install the air compressor on the engine as directed in paragraph 195c.

## 254. Treadle Valve (fig. 184)

### a. Removal and Disassembly.

- (1) Remove the treadle valve as directed in paragraph 191a.

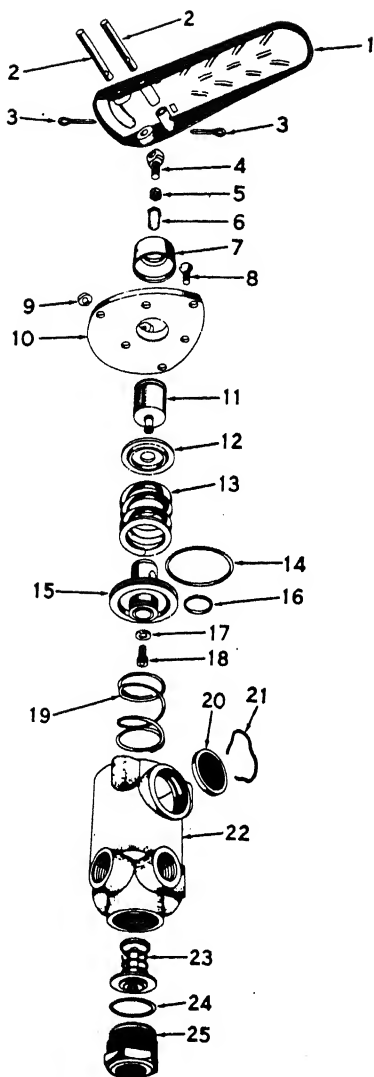
*Note.* Plug all openings and remove all dirt and grease from the exterior of the treadle valve by brushing with an approved cleaning solvent.

- (2) Remove the cotter pins (3) and push out the pins (2) that secure the treadle (1) to the mounting flange (10), and the push rod (4) to the treadle.
- (3) Remove the push rod end (6) and nut (5) from the push rod (4).
- (4) Remove the boot (7) and treadle stop button (9) from the mounting flange (10).
- (5) Remove the three screws (8) that secure the mounting flange to the valve body; remove the mounting flange, assembled piston and metering spring stem, and metering spring (13).
- (6) Remove the preformed packings (14 and 16) from the piston (15).
- (7) Remove the screw (18) and washer (17) that secure the metering spring stem (11) to the piston; remove the metering spring stem, spring retainer (12), and metering spring (13).
- (8) Remove the inlet valve cap (25) from the valve body (22); remove the valve (23) and preformed packing (24).
- (9) Remove the lockwire (21) that secures the filter (20) in the valve body; push the filter from its opening.

### b. Cleaning and Inspection.

- (1) Wash all metallic parts with an approved cleaning solvent; dry with clean, dry compressed air. Wipe dirt from the remaining parts with a clean, dry cloth.
- (2) Inspect the valve body for cracks,





MSC 3805-201-15/184

- |                         |                      |
|-------------------------|----------------------|
| 1 Treadle               | 14 Preformed packing |
| 2 Pin                   | 15 Piston            |
| 3 Cotter pin            | 16 Preformed packing |
| 4 Push rod              | 17 Washer            |
| 5 Nut                   | 18 Screw             |
| 6 Push rod end          | 19 Spring            |
| 7 Boot                  | 20 Filter            |
| 8 Screw                 | 21 Lockwire          |
| 9 Treadle stop button   | 22 Valve body        |
| 10 Mounting flange      | 23 Valve             |
| 11 Metering spring stem | 24 Preformed packing |
| 12 Spring retainer      | 25 Inlet valve cap   |
| 13 Metering spring      |                      |

Figure 184. Treadle valve, exploded view.

scoring, stripped threads, or other damage.

- (3) Inspect the piston for cracks, nicks, scratches, or excessive wear. Inspect the piston exhaust seat for wear or damage; correct for slight wear by

lapping with a piece of crocus cloth on a flat surface.

- (4) Inspect the inlet and exhaust valves for wear or damage.
- (5) Inspect the springs for loss of tension, cracks, or distortion.
- (6) Inspect the treadle, metering spring stem, mounting flange, pins, and push rods for cracks, excessive wear, or damage.
- (7) Replace all preformed packings, cotter pins, and damaged or excessively worn parts.

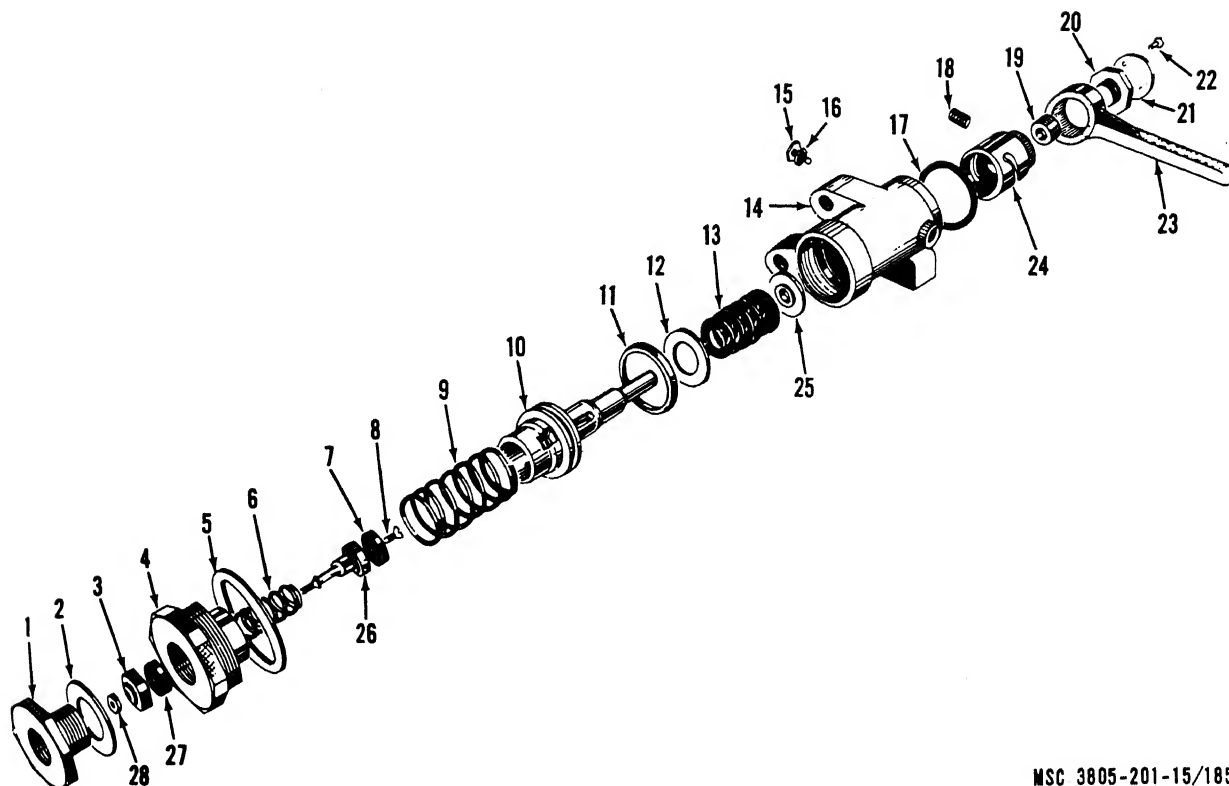
#### c. Reassembly and Installation.

- (1) Install the filter (20) into its opening on the valve body (22); secure with the lockwire (21).
- (2) Position the valve (23) and preformed packing (24) in the opening at the bottom of the valve body; secure with the inlet valve cap (25).
- (3) Position the metering spring (13), spring retainer (12), and metering spring stem (11) on the piston; secure with the washer (17) and screw (18).
- (4) Install the preformed packings (16 and 14) on the piston (15).
- (5) Position the spring (19), assembled piston and metering spring stem (taking care not to damage or dislodge the preformed packings), and mounting flange (10) on the valve body; secure with the three screws (8).
- (6) Install the treadle stop button (9) and boot (7) on the mounting flange.
- (7) Position the push rod (4) on the treadle (1); secure with a pin (2) and cotter pin (3). Install a nut (5) and push rod end (6) on the push rod.
- (8) Position the assembled treadle and push rod on the mounting flange, inserting the push rod into the metering spring stem; secure with the remaining pin (2) and cotter pin (3).
- (9) Install the treadle valve as directed in paragraph 191c.

## 255. Handbrake Valve (fig. 185)

### a. Removal and Disassembly.

- (1) Remove the handbrake valve as directed in paragraph 190a.
- (2) Plug all openings and remove all dirt



MSC 3805-201-15/185

1 Inlet port cap	9 Piston return spring	16 Lockwasher	22 Screw
2 Gasket	10 Metering piston	17 Preformed packing	23 Handle
3 Air inlet valve	11 Piston cup	18 Setscrew	24 Actuating cam
4 Valve housing cap	12 Washer	19 Piston travel adjusting nut	25 Spring retainer
5 Gasket	13 Metering spring	20 Handle retainer nut	26 Air exhaust valve
6 Valve return spring	14 Housing	21 Nameplate	27 Inlet valve disk
7 Exhaust valve disk	15 Pin		28 Nut
8 Screw			

Figure 185. Handbrake valve, exploded view.

- and grease from the exterior of the valve; secure the valve in a suitable bench vise for disassembly.
- (3) Remove the inlet port cap (1) and gasket (2) from the valve.
- (4) Remove the valve housing cap (4), using  $1\frac{1}{16}$ -inch heavy duty socket wrench to prevent damage to the housing or cap; remove the gasket (5) and piston return spring (9).
- (5) Remove the nut (28) that secures the air inlet valve (3) and disk (27) to the exhaust valve stem; remove the inlet valve, disk, valve return spring (6), and assembled exhaust valve and disk.
- (6) Remove the screw (8) that secures the disk (7) to the air exhaust valve (26); remove the disk.
- (7) Remove the handle retainer nut (20)
- from the actuating cam; insert a small drift through the opening and push the piston from the housing.
- (8) Remove the spring retainer (25), metering spring (13), and washer (12) from the piston; carefully remove the piston cup (11) from the piston (10).
- (9) Pull the handle (23) from the serrations of the actuating cam (24).
- (10) Unscrew and remove the two actuating cam pins (15) and lockwashers (16) that secure the actuating cam to the housing (14); remove the actuating cam and preformed packing (17) from the housing.
- (11) Remove the two setscrews (18) and piston travel adjusting nut (19) from the actuating cam.
- (12) If the nameplate (21) is damaged, re-

move the two drive screws (22) that secure it to the handle retainer nut (20); remove the nameplate.

*b. Cleaning and Inspection.*

- (1) Thoroughly clean all metal parts with an approved cleaning solvent; dry with clean, dry compressed air.
- (2) Inspect the housing for cracks, grooves, excessive wear, stripped threads, or other damage.
- (3) Inspect the valve disks for cracks, pits, or excessive wear.
- (4) Inspect the piston for cracks, excessive wear, or a damaged valve seat.
- (5) Inspect the actuating cam for cracks, excessive wear of the cam grooves, or stripped threads.
- (6) Check the springs for cracks, distortion, and for pressure load and free length as follows:

Piston return spring-----10 lb at 1¼ in.  
Valve return spring-----5 lb at ½ in.  
Metering spring-----176-215 lb at 1⅞ in.  
(1¼ in. free length)

- (7) Inspect the piston cup for hardening, softening, swelling, cracks, or signs of wear.
- (8) Replace all gaskets, preformed packings, valve disks, and excessively worn or damaged parts.

*c. Reassembly and Installation.*

- (1) Lightly coat the rod of the piston (10), metering spring (13), and actuating cam (24) with grease.
- (2) Install a new preformed packing (17) in its groove near the top of the housing (14).
- (3) Install the piston travel adjusting nut (19) and two setscrews (18) into the actuating cam (24).
- (4) Position the actuating cam in the housing so that the grooves are aligned with the holes for the actuating cam pins; install the two actuating cam pins (15) and lockwashers (16).
- (5) Carefully install the piston cup (11) in the groove of the piston (10), so that the closed part of the cup is toward the piston rod.
- (6) Position the washer (12), metering spring (13), and spring retainer (25) on the piston; install the assembled parts into the housing.

(7) Position a new exhaust valve disk (7) on the air exhaust valve (26); secure with the screw (8).

(8) Install a new inlet valve disk (27) on the air inlet valve (3).

(9) Position the assembled exhaust valve, valve return spring (6), and assembled inlet valve on the valve housing cap (4); secure with the nut (28).

(10) Position the piston return spring (9) and gasket (5) on the valve housing cap; install the valve housing cap on the housing.

(11) Install the inlet port cap (1) and gasket (2).

(12) Adjust the valve as directed in *d* below.

(13) If removed, position the nameplate (21) on the handle retainer nut (20); secure with the two screws (22).

(14) Position the handle (23) on the actuating cam; secure with the handle retainer nut.

(15) Test the handbrake valve as directed in *e* and *f* below.

(16) Install the handbrake valve as directed in paragraph 190c.

*d. Valve Adjustment.*

(1) Disconnect the line from the handbrake valve outlet port.

(2) With the handbrake valve at the fully released position, remove the handle retainer nut (20) and handle (23).

(3) Loosen the two setscrews (18) that secure the piston travel adjusting nut (19).

(4) Apply air pressure equal to reservoir air pressure through the inlet port line.

(5) Turn the piston travel adjusting nut clockwise with a broad-blade screwdriver until air begins to escape from the outlet port.

(6) Turn the piston travel adjusting nut counterclockwise one and one half turns; tighten the two setscrews, making sure they contact the flats machined on the piston travel adjusting nut.

(7) Position the handle (23) on the actuating cam; secure with the handle retainer nut (20).

(8) Connect the line to the handbrake valve outlet port.

*e. Air Leakage Test.*

- (1) Coat the exterior of the handbrake valve with soap suds; a leakage of less than one bubble per second at the exhaust port is acceptable.
- (2) With the handle at the fully released position, check with soap suds for leakage at the exhaust port; bubbles indicate leakage at the inlet valve.
- (3) With the handle at the applied position, check with soap suds for leakage at the exhaust port; bubbles indicate leakage at the exhaust valve.

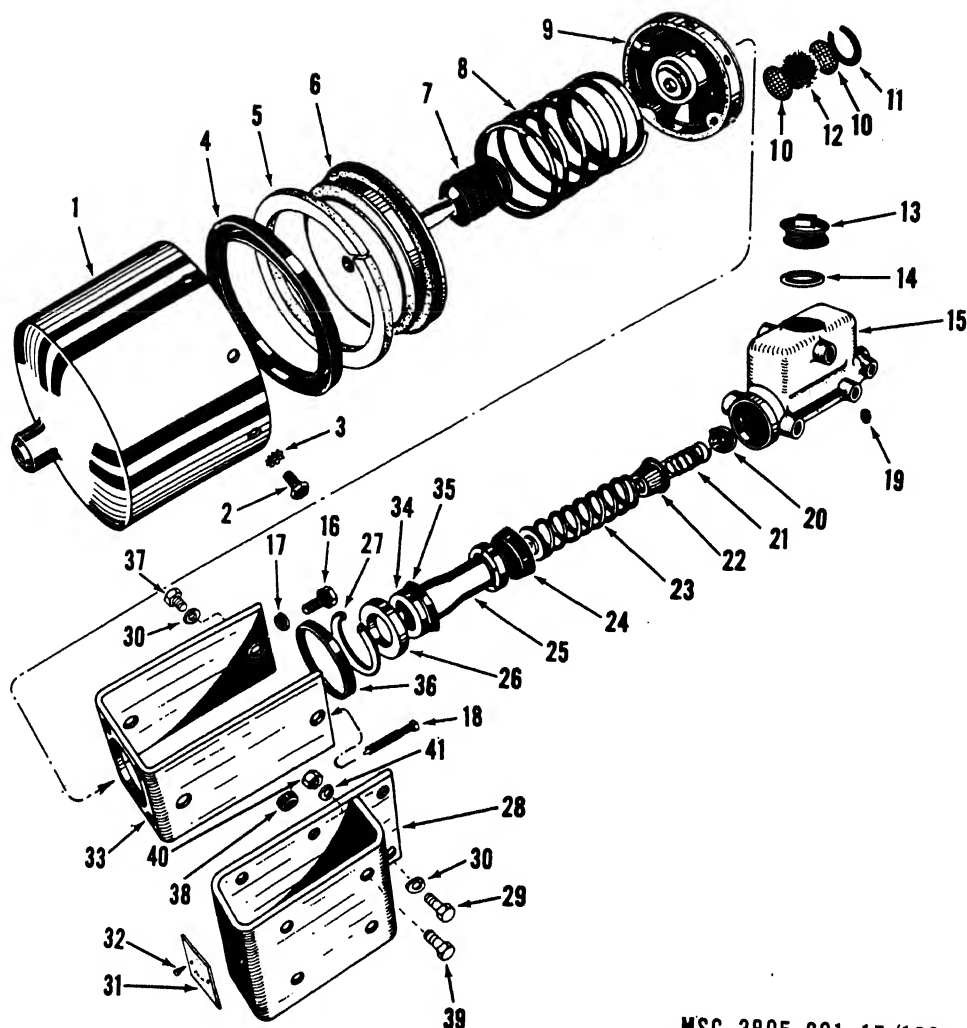
*f. Valve Operation Test.*

- (1) Install the handbrake valve on a test stand, if available. Where a test stand is not available, install the handbrake valve on the vehicle as directed in paragraph 190c. Install an accurate test gage in the brake delivery line.
- (2) With 100-psi pressure, fully apply the handbrake valve. The applied pressure registered on the delivery line test gage should approximate the pressure indicated on the reservoir gage.
- (3) Partially release the handbrake valve in graduated intervals. At each interval, the applied pressure should be progressively lower in ratio to the reservoir pressure.
- (4) Partially apply the handbrake valve in graduated intervals, holding it in each position for 20 to 30 seconds. The applied pressure gage and reservoir pressure gage must show different unchanging pressures and the pressure differential must remain constant at each setting.
- (5) When the handbrake valve is in the fully released position, the test gage should indicate zero pressure.
- (6) Remove the handbrake valve from the test stand, or remove the test gage from the brake delivery line.

## **256. Power Cluster**

*a. Removal and Disassembly.*

- (1) Disconnect the tubes (7, 9, and 18, fig. 83) from the power cluster. Plug the tubes to prevent the entry of dirt.
- (2) Remove the four capscrews (39, fig. 186), nuts (40), and lockwashers (41) that secure the power cluster to the loader frame; remove the power cluster.
- (3) Plug all openings and thoroughly clean the exterior of the power cluster by brushing with an approved cleaning solvent.
- (4) Remove the eight screws (2, fig. 186) and lockwashers (3) that secure the air cylinder shell (1) to the air cylinder head (9); remove the air cylinder shell, assembled piston (6), piston return spring (8), and boot (7).
- (5) Remove the air cylinder piston cup (4) and wiper (5) from the air cylinder piston (6).
- (6) Remove the three screws (29), lockwashers (30), and spacer (38) that secure the mounting bracket (28) to the hydraulic cylinder; remove the mounting bracket.
- (7) If the nameplate (31) is damaged, remove the two pins (32) that secure it to the mounting bracket; remove the nameplate.
- (8) Remove the two screws (37) and lockwashers (30) that secure the assembled hydraulic cylinder to the bracket (33); remove the assembled hydraulic cylinder and the seal ring (36).
- (9) Remove the three screws (16), piston stroke indicator (18), and four lockwashers (17) that secure the bracket to the air cylinder head (9); remove the bracket.
- (10) Remove the retaining ring (11) from the air cylinder head; push out the two filter screens (10) and filter hair (12).
- (11) Remove the lockwire (27) that secures the piston stop plate (26) in the cylinder and tank casting; remove the piston stop plate, assembled piston, piston primary cup (24), piston return spring (23), check valve retainer (22), spring (21), and the check valve and seat (20).
- (12) Slide the piston secondary cup ring (34) over the rear bearing surface of the piston (25); pull the piston secondary cup (35) from the piston.
- (13) Remove the filler plug (13), gasket



MSC 3805-201-15/186

- |                           |                              |                         |                         |
|---------------------------|------------------------------|-------------------------|-------------------------|
| 1 Air cylinder shell      | 12 Filter hair               | 21 Spring               | 32 Pin                  |
| 2 Screw                   | 13 Filler plug               | 22 Check valve retainer | 33 Bracket              |
| 3 Lockwasher              | 14 Gasket                    | 23 Piston return spring | 34 Piston secondary cup |
| 4 Air cylinder piston cup | 15 Cylinder and tank casting | 24 Piston primary cup   | 35 Piston secondary cup |
| 5 Wiper                   | 16 Screw                     | 25 Piston               | 36 Seal ring            |
| 6 Air cylinder piston     | 17 Lockwasher                | 26 Piston stop plate    | 37 Screw                |
| 7 Boot                    | 18 Piston stroke indicator   | 27 Lockwire             | 38 Spacer               |
| 8 Piston return spring    | 19 Plug                      | 28 Mounting bracket     | 39 Capscrew             |
| 9 Air cylinder head       | 20 Check valve and seat      | 29 Screw                | 40 Nut                  |
| 10 Filter screen          |                              | 30 Lockwasher           | 41 Lockwasher           |
| 11 Retaining ring         |                              | 31 Nameplate            |                         |

Figure 186. Power cluster, exploded view.

(14), and plug (19) from the cylinder and tank casting (15).

*b. Cleaning and Inspection.*

*Note.* The air cylinder parts and hydraulic cylinder parts must be cleaned separately.

- (1) Thoroughly clean all metal air cylinder parts by washing with an approved cleaning solvent; dry with

clean, dry compressed air. Wipe all dirt from the remaining air cylinder parts with a clean cloth.

- (2) Clean the parts of the hydraulic cylinder by washing with hydraulic brake fluid or denatured alcohol.
- (3) Steam-clean the cylinder and tank casting to remove all dirt and reservoir

sediment. Make sure that the intake and bypass ports are open, but do not clean the bypass port with a wire, as the port may be enlarged or burred.

- (4) Inspect the air cylinder shell for scratches, dents, or other mars on the bore, which would damage the piston, and cracks or other damage.
- (5) Inspect the air cylinder piston for cracks and loosening or distortion of the piston rod.
- (6) Inspect the bore of the cylinder and tank casting for any scratches, grooves, or checks; hone the cylinder bore, if necessary, or polish with crocus cloth. Clean the cylinder with denatured alcohol after honing or polishing.
- (7) Inspect the hydraulic cylinder piston for scratches or grooves. Check that the fingers covering the passages in the piston face are not damaged or distorted.
- (8) Inspect the springs for distortion, loss of tension, or corrosion.
- (9) Inspect the piston cups for cracks, softening, swelling, signs of wear, or deterioration.
- (10) Replace the gasket and all damaged or defective parts.

*c. Reassembly and Installation.*

- (1) Install the filler plug (13, fig. 186), gasket (14), and plug (19) in the cylinder and tank casting (15).
- (2) Install the piston secondary cup (35) on the piston (25); slide the piston secondary cup ring (34) into position over the piston secondary cup.

*Note.* Lubricate the hydraulic cylinder parts with clean brake fluid before they are installed.

- (3) Carefully position the parts in the cylinder and tank casting (15) in the following order: the check valve and seat (20); spring (21); check valve retainer (22); piston return spring (23); piston primary cup (24), with the flat surface toward the piston; piston (25), with the drilled piston face inward; and piston stop plate (26). Press the parts into the bore; secure by seating the lockwire (27) in its groove.

- (4) Position the filter screen (10), filter hair (12), and second filter screen on the air cylinder head (9); secure with the retaining ring (11).

- (5) Soak the wiper (5) in SAE-10 oil before assembly. Position the wiper and air cylinder piston cup (4) on the air cylinder piston (6).
- (6) Force the small diameter lip of the boot (7) into the groove on the air cylinder piston.
- (7) Carefully slide the assembled air cylinder piston into the air cylinder shell (1). Position the piston return spring (8) and air cylinder head (9) with the holes aligned with the holes in the air cylinder shell; secure with the eight screws (2) and lockwashers (3).
- (8) Use a small diameter drift through the air inlet port to force the air cylinder piston through its entire stroke; this should seat the boot on the air cylinder head.
- (9) Position the bracket (33) on the assembled air cylinder; secure with the three screws (16), piston stroke indicator (18), and four lockwashers (17).
- (10) If removed, install the nameplate (31) on the mounting bracket (28) with two pins (32).
- (11) Position the assembled hydraulic cylinder, seal ring (36), and the mounting bracket on the air cylinder and bracket; secure with the three screws (29), two screws (37), five lockwashers (30), and spacer (38).
- (12) Test the power cluster as directed in *d* below.
- (13) Install the power cluster on loader as follows:
  - (a) Position the power cluster on the loader frame; secure with the four capscrews (39), nuts (40), and lockwashers (41).
  - (b) Connect the tubes (7, 9, and 18, fig. 83) to the power cluster.

*d. Testing (fig. 186).*

- (1) Mount the power cluster on a test stand that includes an application valve, an air pressure supply to deliver 100-psi air pressure, a hydraulically actuated device that offers

resistance to 1,500 psi, a gage for measuring the application air pressure between 0 and 100 psi, and a gage for measuring the hydraulic line pressure between 0 and 1,500 psi.

- (2) With 100-psi air pressure applied to the power cluster air cylinder, coat the air cylinder shell (1), piston stroke indicator (18), and filter opening of the air cylinder head (9) with soap suds. Bubbles indicate that air is passing the air cylinder piston. If leakage is present, remove the air cylinder shell as directed in *a*(4) above; inspect the parts for defects.
- (3) Apply and release the air pressure several times; note the position of the piston stroke indicator (18). The piston should promptly return to the fully released position each time. If the piston does not return fully or returns slowly, it indicates binding of the piston or piston rod, or a defective piston return spring (8). Repair or replace defective parts as required.

- (4) Apply 100-psi air pressure to the air cylinder. The hydraulic pressure should indicate approximately 1,500 psi. Hold in the applied position for 30 seconds; the hydraulic pressure should be maintained.

- (5) Apply the air pressure slowly about 12 times; each time release fully. The hydraulic pressure should drop to less than 6 to 12 psi at each release.

- (6) Apply only 5 to 7 psi of air pressure and hold the application valve in this position. Check the piston stroke indicator; wait at least 2 minutes and recheck the piston stroke indicator. A perceptible increase in stroke indicates a hydraulic leak past the piston primary cup (24).

- (7) If the hydraulic cylinder does not build or maintain proper pressure, does not release properly, or shows evidence of leakage, disassemble as directed in *a*(8) through (12) above; repair or replace parts as required.

## Section VIII. CARRIER REPAIR INSTRUCTIONS

### 257. Torque Converter and Transmission

*a. General.* The transmission is a constant-mesh, four-speed, power-shifted, full-reversing type with an integral torque converter. The propeller shaft from the engine drives the converter pump and the accessory drive shaft. The converter pump directs the oil against the blades of the turbine wheel and transmits the power through the turbine shaft to the input gear of the transmission. The oil from the turbine wheel is redirected back to the converter pump by the reaction member. The power flow through the gears of the transmission is controlled by three hydraulically operated, oil-cooled, double-clutch assemblies. These assemblies engage or disengage gears in response to manually operated shift levers that move the valve spools of the control valve assembly. A manually operated shift sleeve connects the transmission output to either the front drive axle or to both drive axles simultaneously.

*b. Removal.*

- (1) Park the loader on a suitable, level work area; block all wheels securely.

- (2) Drain the torque converter and transmission lubrication system as directed in paragraph 211.

- (3) Disconnect the 90° nipple (5, fig. 103) from the cross (6) on the transmission housing. Disconnect the tube (9) from the transmission housing.

- (4) Remove the torque converter charging pump as directed in paragraph 214a.

- (5) Remove the main hydraulic pump as directed in paragraph 206a.

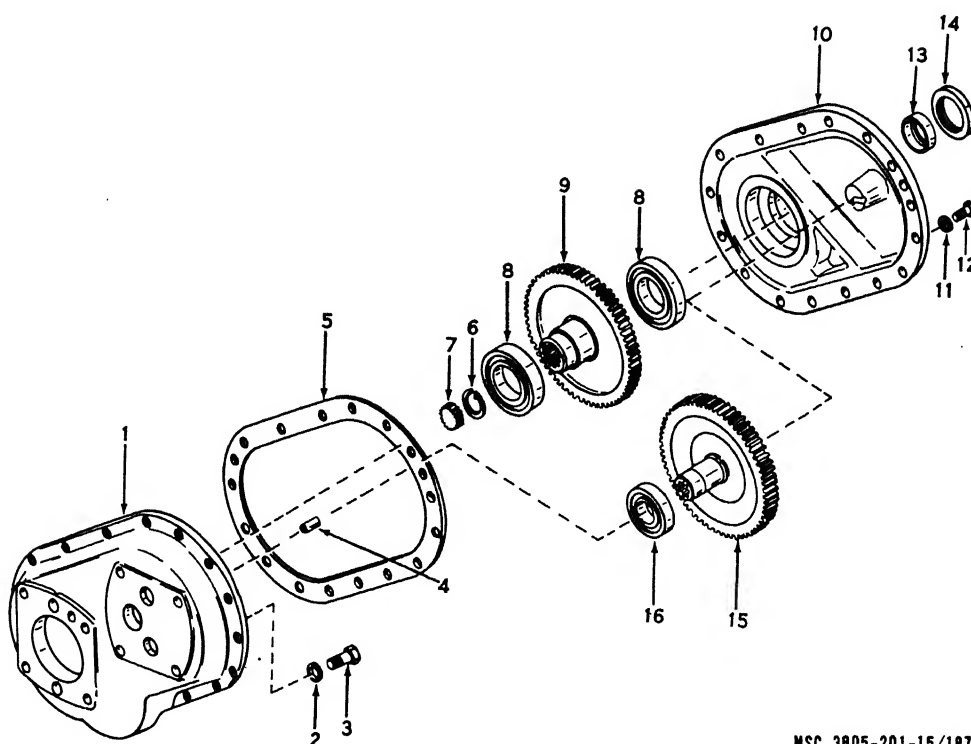
- (6) Remove the upper drive shaft as directed in paragraph 216a.

- (7) Disconnect the treadle valve-to-dump valve tube from the dump valve.

- (8) Disconnect the linkage from the transmission control valve as directed in paragraph 172b(2). Disconnect the parking brake linkage as directed in paragraph 175c.

- (9) Remove the cotter pin (20, fig. 76) and clevis pin (21) that secure the rod (24) of the axle disengage linkage to the transmission shift shaft.





MSC 3805-201-15/187

1 Front pump drive housing	5 Gasket	10 Rear pump drive housing	13 Seal wiper
2 Lockwasher	6 Retaining ring	11 Lockwasher	14 Seal
3 Screw	7 Spline seal plug	12 Screw	15 Driven gear
4 Dowel pin	8 Ball bearing		16 Ball bearing
	9 Driver gear		

Figure 187. Pump drive housing, exploded view.

- (10) Remove the lower drive shafts as directed in paragraph 217a.
- (11) Disconnect and remove the switch (8, fig. 103) and sender (7) from the torque converter and transmission.
- (12) Position a suitable dolly or jacks beneath the transmission to securely support it.
- (13) Remove the four screws and lockwashers that secure the transmission to each of its two brackets; carefully lower the transmission from the loader.
- (14) Clean all grease and dirt from the exterior of the transmission before beginning disassembly by steam-cleaning or brushing with an approved cleaning solvent.

c. Disassembly.

- (1) Disassemble the pump drive housing as follows:

- (a) Remove the 16 screws (12, fig. 187) and lockwashers (11) that secure

the rear pump drive housing (10) to the front pump drive housing (1); remove the rear pump drive housing and gasket (5).

- (b) Remove the seal (14) from the rear pump drive housing.
- (c) If the two dowel pins (4) are loose or damaged, remove them from the front pump drive housing.
- (d) Remove the assembled driver gear (9), bearing (8), and plug (7) from the pump drive housing.
- (e) Remove the four screws (3) and lockwashers (2) that secure the front pump drive housing to the transmission housing; remove the assembled front pump drive housing and gears; remove the gasket.
- (f) Remove the two ball bearings (8) from the driver gear (9); remove the retaining ring (6) and remove the plug (7) from the bore of the driver gear.

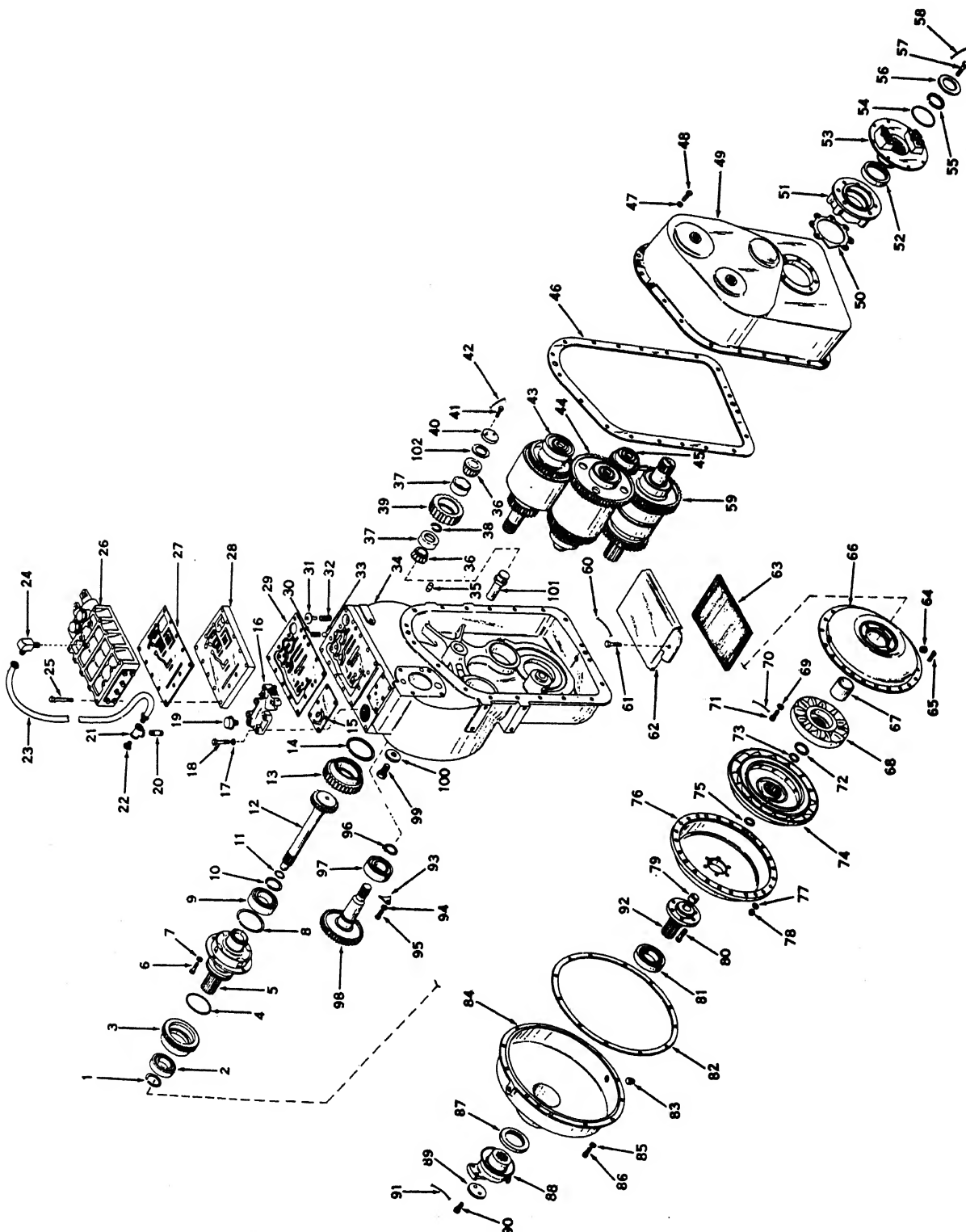


Figure 188. Transmission assembly, exploded view.

MSC 3805-201-15/188

1	Retaining ring	27	Gasket	51	Brake adapter	77	Lockwasher
2	Bearing	28	Adapter plate	52	Seal	78	Nut
3	Accessory drive gear	29	Gasket	53	Rear output flange	79	Bushing
4	Oil ring	30	Spring	54	Preformed packing	80	Capscrew
5	Ground sleeve	31	Lubrication valve	55	Seal ring	81	Ball bearing
6	Capscrew	32	Spring	56	Washer	82	Gasket
7	Lockwasher	33	Ball	57	Capscrew	83	Plug
8	Retaining ring	34	Transmission housing	58	Lockwire	84	Housing cover
9	Ball bearing	35	Dowel	59	Output shaft assembly	85	Lockwasher
10	Retaining ring	36	Bearing cone	60	Lockwire	86	Capscrew
11	Oil ring	37	Bearing cup	61	Setscrew	87	Seal
12	Turbine shaft	38	Retaining ring	62	Baffle	88	Flange
13	Transmission input gear	39	Reverse idler gear	63	Screen	89	Washer
14	Retaining ring	40	Washer	64	Plug	90	Capscrew
15	Gasket	41	Capscrew	65	Screw	91	Lockwire
16	Dump valve	42	Lockwire	66	Converter pump	92	Input shaft
17	Lockwasher	43	Forward and reverse clutch assembly	67	Spacer	93	Bearing retainer clip
18	Capscrew	44	Range clutch assembly	68	Reaction member	94	Lockwasher
19	Breather	45	Splitter clutch assembly	69	Flat washer	95	Capscrew
20	Nipple	46	Gasket	70	Lockwire	96	Retaining ring
21	Tee	47	Lockwasher	71	Capscrew	97	Ball bearing
22	Bushing	48	Capscrew	72	Retaining ring	98	Accessory drive shaft
23	Hose	49	Housing rear cover	73	Retaining ring	99	Capscrew
24	Elbow	50	Gasket	74	Turbine	100	Washer
25	Capscrew			75	Retaining ring	101	Reverse idler shaft
26	Control valve			76	Cover	102	Shim

Figure 188—Continued.

- (g) If excessively worn or damaged, remove the wiper (13) from the housing (10).
  - (h) Remove the assembled driven gear (15) and ball bearing (16) from the front pump drive housing; remove the ball bearing from the driven gear.
- (2) Disassemble the torque converter section as follows:
    - (a) Place the transmission on a suitable stand in an upright position.
    - (b) Cut the lockwire (91, fig. 188) to release the two capscrews (90); remove the two screws, retainer, and washer (89).
    - (c) Use a puller to remove the flange (88) from the converter input shaft.
    - (d) Remove the 12 capscrews (86) and lockwashers (85) that secure the converter housing cover (84) to the transmission housing (34); install the two screws in the puller holes to loosen the converter housing cover. Remove the converter housing cover and gasket (82).
    - (e) Remove the seal (87) from the converter housing cover.
    - (f) Pull the ball bearing (81) from the converter input shaft.
    - (g) Remove the capscrews (80) that secure the converter input shaft assembly to the cover; remove the converter input shaft assembly. If the bushing (79) is excessively worn or damaged, remove it from the converter input shaft.
    - (h) Index-mark the cover to the converter pump. Remove the 24 nuts (78) and lockwashers (77) that secure the cover (76) to the converter pump assembly; remove the cover.
    - (i) Remove the retaining ring (75) that secures the turbine (74) to the turbine shaft; remove the turbine, using two large cotter pins or two pieces of hooked wire as shown in figure 189.
    - (j) Remove the inner turbine retaining ring (73, fig. 188) and the reaction member retaining ring (72); remove the reaction member (68) and the spacer (67).
    - (k) Remove the retaining ring (1) that retains the assembled converter pump (66) on the ground sleeve (5); remove any burrs that may have been raised by the retaining ring. Remove the assembled converter pump.
    - (l) Remove the lockwire (70), six capscrews (71), and washers (69) that secure the accessory drive gear (3) to the converter pump. Press the

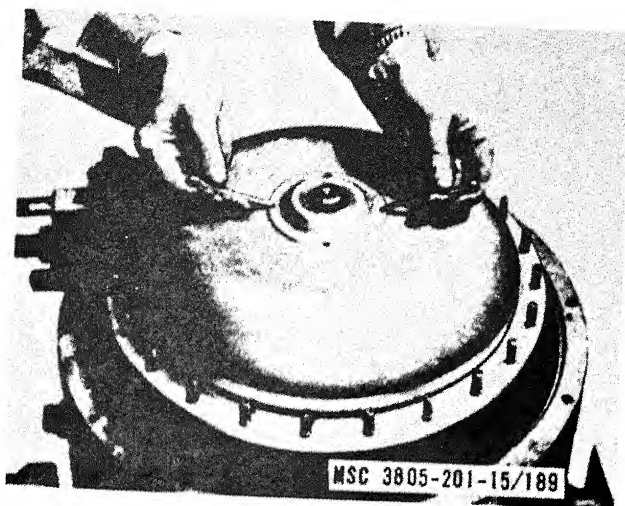


Figure 189. Removing the turbine.

accessory drive gear from the converter pump; press the ball bearing (2) from the accessory drive gear.

- (m) Remove any of the 24 converter pump screws (65) that are damaged.
- (n) Rotate the accessory drive shaft (98) so that the cap screw (95) and lockwasher (94) that secure the bearing retainer clip (93) can be

removed; remove the screw, lockwasher, and bearing retainer clip as shown in figure 190.

- (o) Tap the end of the accessory drive shaft with a soft drift to remove the accessory drive shaft from the transmission. Remove the retaining ring (96, fig. 188) and the ball bearing (97) from the accessory drive shaft.
- (p) Remove the oil ring (4) from the ground sleeve (5).
- (q) Remove the five cap screws (6) and lockwashers (7) that secure the assembled ground sleeve and turbine shaft (12) to the transmission housing; remove the assembled ground sleeve and turbine shaft.
- (r) Remove the retaining ring (14) that retains the turbine shaft; remove the turbine shaft. Remove the oil ring (11) from the turbine shaft.
- (s) Remove the retaining ring (10) that retains the assembled ball bearing and input gear to the ground sleeve;



Figure 190. Accessory drive shaft, showing removal of bearing retainer clip.

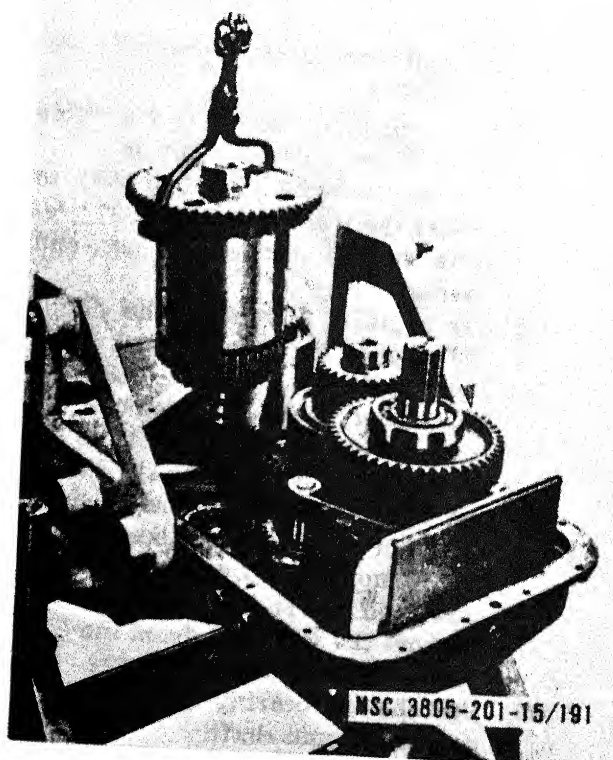


Figure 191. Range clutch assembly, removal.

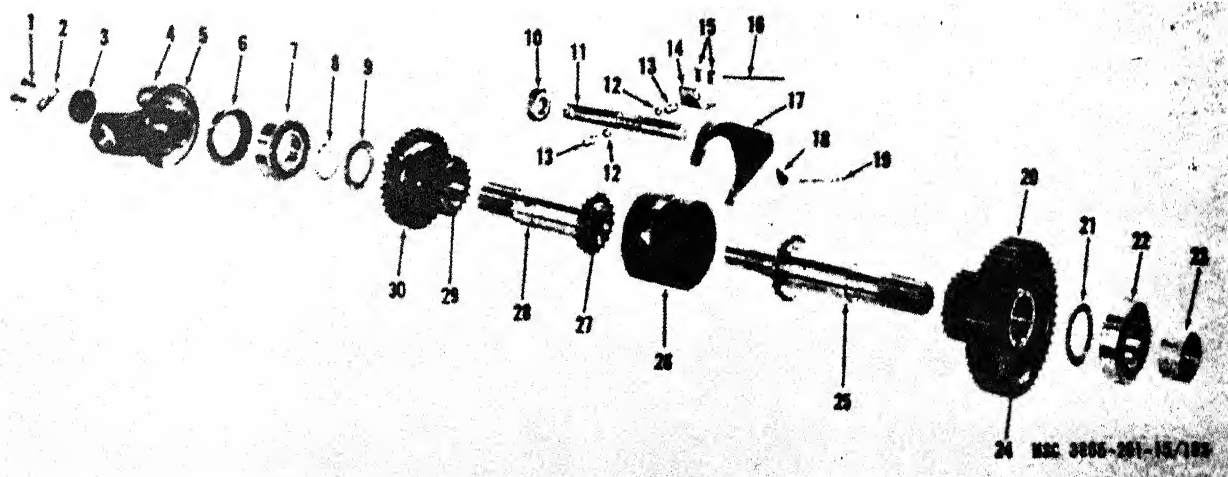


Figure 192. Removing the forward and reverse clutch assembly and the reverse idler gear.

remove the input gear (13) and ball bearing (9).

(t) Remove the retaining ring (8);

- press the ball bearing from the input gear.
- (3) Disassemble the clutch section of the transmission as follows:
    - (a) Cut the lockwire (1, fig. 193) to release the two screws (2) that secure the front flange (6); remove the screws, washer (3), seal rings (4), and preformed packing (5).
    - (b) Use a puller to remove the front flange and slinger; remove the slinger (7) from the flange (6).
    - (c) Position the transmission assembly on a stand or suitable blocking, with the torque converter side down.
    - (d) Disassemble the parking brake as directed in paragraph 196a.
    - (e) Cut the lockwire (58, fig. 188) to release the two capscrews (57); remove the two screws, washer, seal rings (55); and preformed packing (54) that secure the rear output flange (53) to the rear output shaft. Use a puller to remove the rear output flange.
    - (f) Remove the seven screws and lockwashers that secure the brake backing plate; remove the brake backing plate, brake adapter housing (51), and gasket (50).



- 1 Screw
- 2 Lock
- 3 Washer
- 4 Flange
- 5 Slinger
- 6 Seal
- 7 Ball bearing
- 8 Retaining ring

- 9 Thrust washer
- 10 Seal
- 11 Shift shaft
- 12 Bearing ball
- 13 Spring
- 14 Clamp
- 15 Screw
- 16 Lockwire

- 17 Shift fork
- 18 Setscrew
- 19 Lockwire
- 20 Low-output gear
- 21 Thrust washer
- 22 Ball bearing
- 23 Spacer

- 24 Bushing
- 25 Rear output shaft
- 26 Shift sleeve
- 27 Bushing
- 28 Front output shaft
- 29 Bushing
- 30 High-output gear

Figure 193. Transmission output shaft, exploded view.

- (g) Remove the seal (52) from the brake adapter housing.
- (h) Remove the 19 capscrews (48) and lockwashers (47) that secure the transmission housing rear cover (49) to the transmission housing. Install the screws in the four puller holes near the corners of the housing rear cover; tighten evenly while tapping the output shaft to loosen the bearing from the cover. Remove the housing rear cover and gasket (46).

*Note.* Do not remove the bearings from the transmission housing rear cover or from the transmission housing unless they are damaged and require replacement.

- (i) Cut the lockwire (60); loosen the setscrew (61) that secures the assembled baffle (62) and screen (63) to the suction tube; remove the baffle and screen and the clamp.
- (j) Remove the range clutch assembly

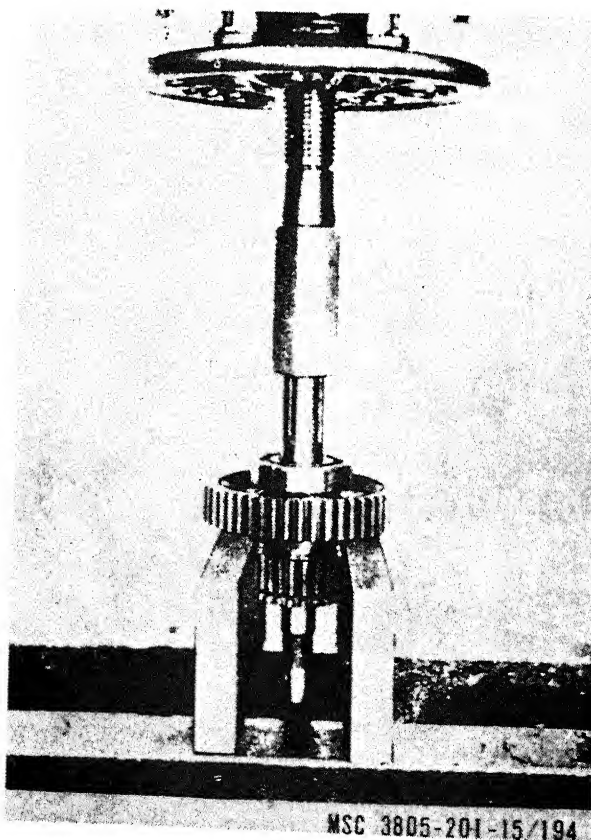
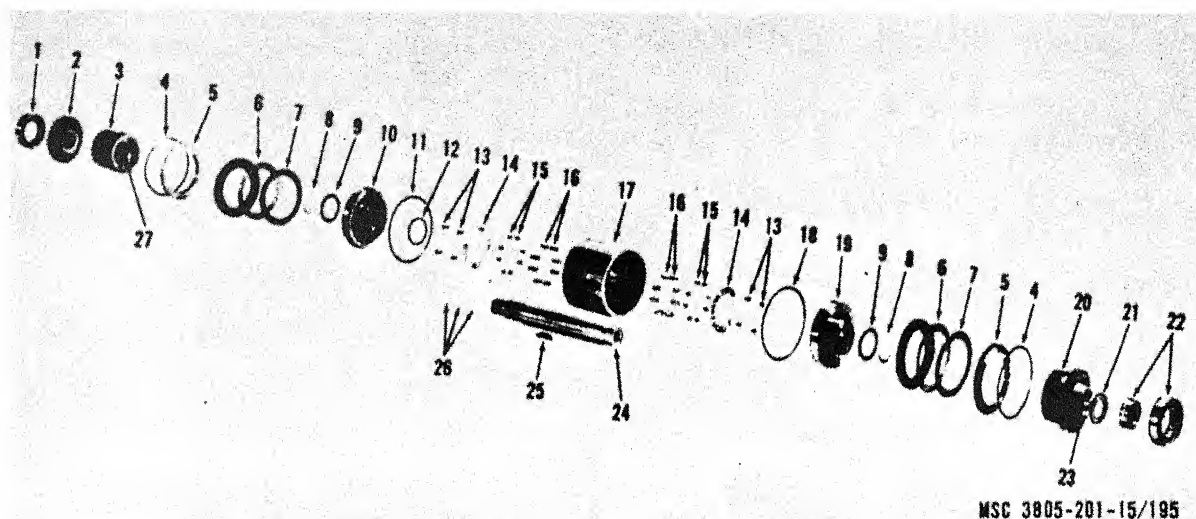


Figure 194. Pressing output shaft from bearing and gear.

- (44) as shown in figure 191.
- (k) Cut the lockwire (42, fig. 188) and remove the two capscrews (41) and washers (40) that secure the reverse idler gear (39) to the reverse idler shaft (101).
- (l) Remove the forward and reverse clutch assembly (43); at the same time, with one hand, lift the assembled reverse idler gear and bearing from its shaft as shown in figure 192.
- (m) If worn or damaged, press the cups (37, figure 188) from the reverse idler gear (39); remove the retaining ring (38).
- (n) Lift the input gear (2, fig. 195) from its roller bearing (1) in the transmission housing.
- (o) Lift the rear output shaft (25, fig. 193) and its assembled parts from the transmission.
- (p) Remove the splitter clutch assembly (45, fig. 188) from the transmission.
- (q) Remove the lockwire (19, fig. 193) and setscrew (18) that secure the shift fork (17) to the shift shaft (11); remove the shift fork and shift sleeve (26).
- (r) Remove the assembled front output shaft; tap the ball bearing (9) loose from the shaft journal if required.
- (s) Remove the low-range gear (2, fig. 197).
- (t) Remove the lockwire (16, fig. 193) and two screws (15) that secure the clamp (14); carefully remove the clamp, poppet spring (13), and bearing ball (12) that it retains against the shift shaft (11).
- (u) Tap lightly with a hammer to start the shift shaft out of the transmission housing; remove the shift shaft and the remaining poppet spring and bearing ball.
- (v) Remove the seal (10) and the front output shaft bore of the transmission housing.
- (w) Position the assembled rear output shaft in a press as shown in figure 194, with the low-output gear supported; press the rear output shaft





MSC 3805-201-15/195

1 Roller bearing	8 Retaining ring	15 Spring guide	22 Roller bearing
2 Input gear	9 Thrust washer	16 Spring	23 Bushing
3 Reverse drive gear	10 Clutch drive piston	17 Clutch drum	24 Shaft assembly
4 Retaining ring	11 Seal	18 Seal	25 Key
5 Backing plate	12 Seal	19 Clutch piston	26 Piston ring
6 Steel disk	13 Screw	20 Forward drive gear	27 Bushing
7 Friction disk	14 Spring retaining plate	21 Thrust washer	

Figure 195. Forward and reverse clutch assembly, exploded view.

- (25, fig. 193) from the ball bearing (22). Remove the ball bearing, thrust washer (21), and low-output gear assembly (20) from the rear output shaft. Tie the shims together and tag them for identification.
- (x) If the two bushings (24, fig. 193) in the low-output gear (20) are ex-

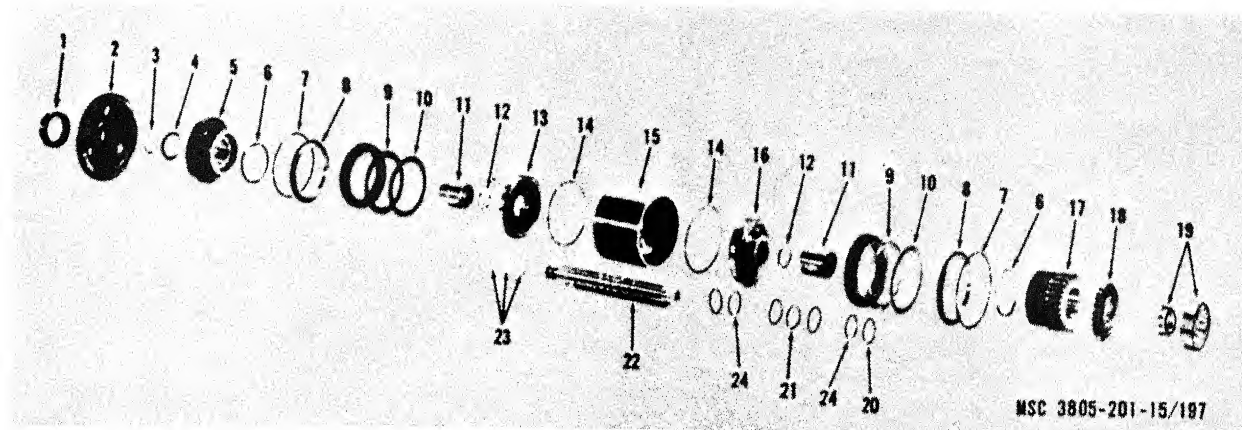
cessively worn or damaged, remove them from the gear.

- (y) Remove the spacer (31) and high-output gear assembly (30) from the front output shaft assembly (28).
- (z) If the two bushings (29) in the high-output gear (30) are excessively worn or damaged, remove them from the gear.
- (aa) If the large bushing (27) or small bushing in the front output shaft (28) is excessively worn or damaged, remove it.
- (ab) Remove the capscrew (99, fig. 188) and washer (100) that secure the reverse idler shaft (101) to the transmission housing; remove the reverse idler shaft.
- (4) Disassemble the forward and reverse clutch assembly as follows:
- (a) With the thumb nail of one hand and the forefinger of the other, unhook and remove each of the three piston rings (26, fig. 195) as shown in figure 196.
- (b) Remove the input gear (2, fig. 195) and reverse drive gear assembly from the forward and reverse shaft assembly (24); if the two bushings



Figure 196. Removing piston from forward and reverse shaft.

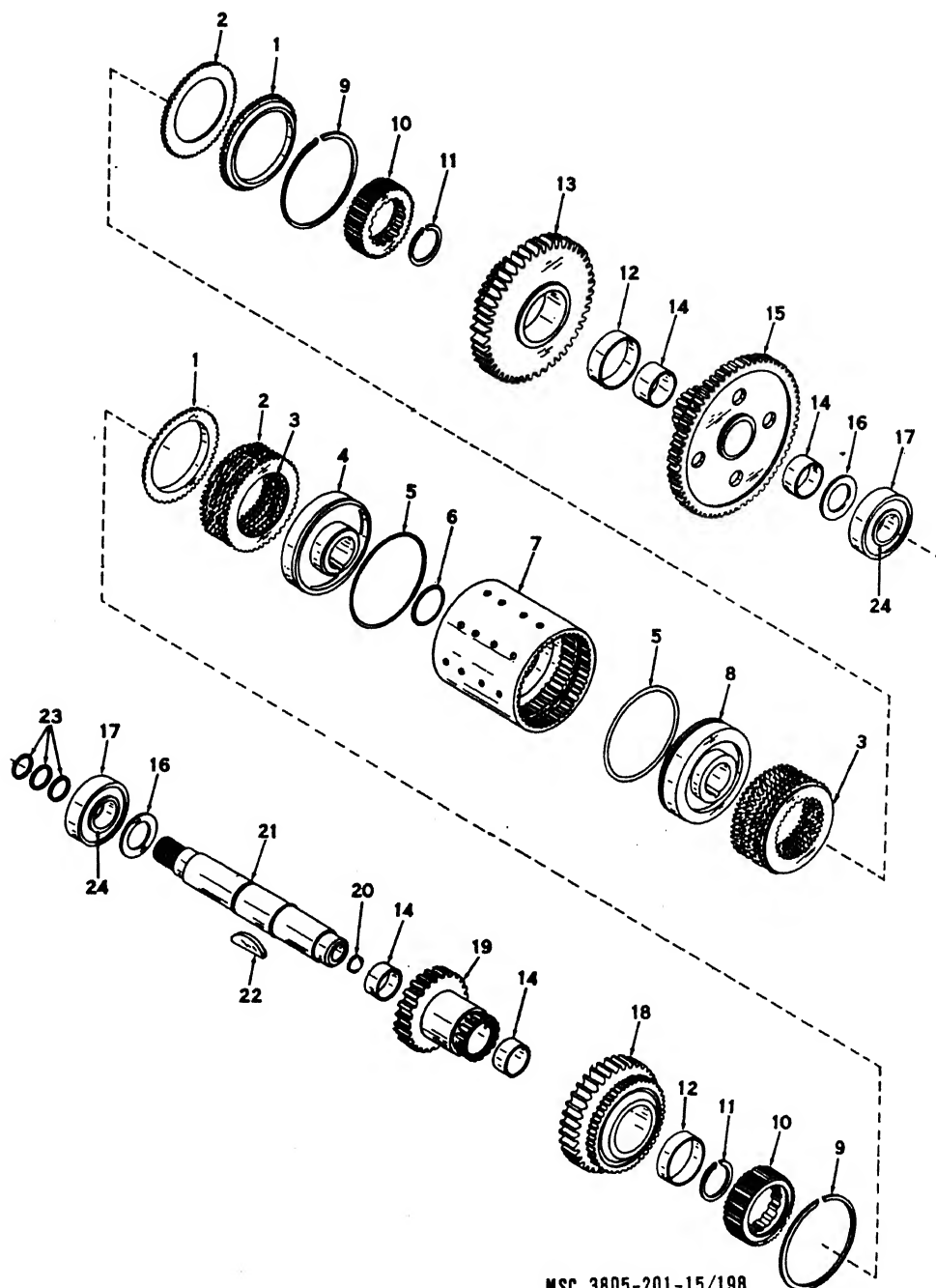




1 Roller bearing	7 Retaining ring	13 Clutch piston	19 Roller bearing
2 Low-range gear	8 Backing plate	14 Seal	20 Backup ring
3 Retaining ring	9 Steel disk	15 Clutch drum	21 Seal
4 Thrust washer	10 Friction disk	16 Clutch drive piston	22 Splitter shaft
5 High-splitter gear	11 Sleeve bearing	17 Low-splitter gear	23 Piston ring
6 Retaining ring	12 Retaining ring	18 High-range gear	24 Seal

Figure 197. Splitter clutch assembly, exploded view.

- (27) in the reverse drive gear (3) are damaged or excessively worn, remove them.
- (c) Remove the retaining ring (8) and thrust washer (9) from the forward and reverse shaft assembly.
- (d) Remove the retaining ring (4) that secures the backing plate (5) in the forward and reverse clutch drum (17); remove the backing plate.
- (e) Remove the six friction disks (7) and five steel disks (6) from the forward and reverse clutch drum.
- (f) Use a bearing puller to remove the inner race of the bearing (22); remove the thrust washer (21) and forward drive gear assembly.
- (g) If the two bushings (23) in the forward drive gear (20) are damaged or excessively worn, remove them.
- (h) Remove the retaining ring (4) that secures the remaining backing plate (5) in the forward and reverse clutch drum (17); remove the backing plate, six friction disks (7), and five steel disks (6).
- (i) Remove the retaining ring (8) and the thrust washer (9) from the forward and reverse shaft assembly.
- (j) Support the inner hub of the clutch piston (19) under the press supports; press against the forward and reverse shaft until the key (25) is free of the clutch piston and the clutch drive piston (10). Remove the forward and reverse shaft and key.
- (k) Remove the clutch piston, clutch drive piston, and seal (12) from the forward and reverse clutch drum; remove the seal (18) from the clutch piston, and the seal (11) from the clutch drive piston.
- (l) Remove the four screws (13) that secure each of the two spring retaining plates (14) to the clutch drum; remove the spring retaining plates, 16 spring guides (15), and springs (16).
- (5) Disassemble the splitter clutch assembly as follows:
  - (a) Remove the three piston rings (23, fig. 197) from the splitter shaft assembly as shown in figure 196.
  - (b) Remove the retaining ring (3, fig. 197) and the thrust washer (4) from the splitter shaft; remove the high-splitter gear (5).
  - (c) Use a bearing puller to remove the inner race of the bearing (19), high-range gear (18), and low-splitter gear (17) from the shaft assembly (22). Tie the shims together and tag them for identification.



MSC 3805-201-15/198

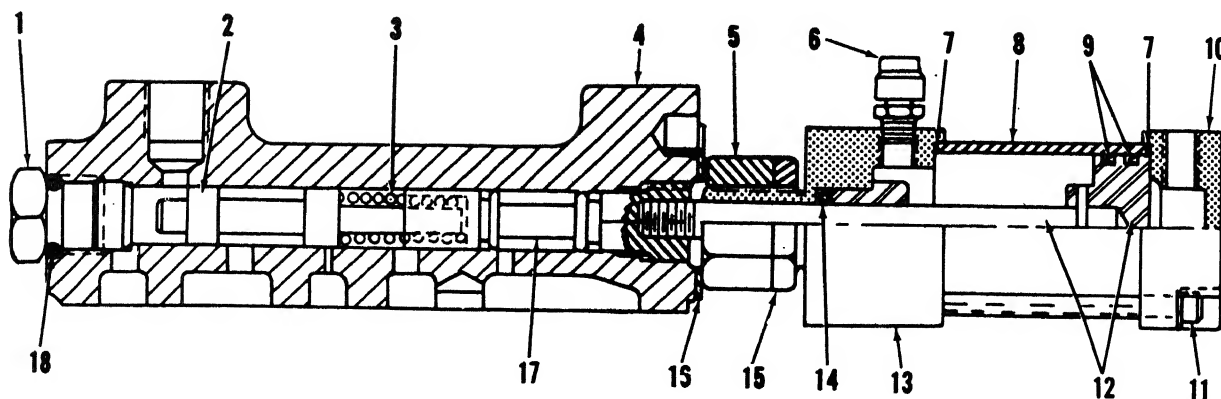
- |                       |                    |                       |                   |
|-----------------------|--------------------|-----------------------|-------------------|
| 1 Backing plate       | 7 Drum             | 13 Forward drive gear | 19 Low-range gear |
| 2 Friction disk       | 8 Clutch piston    | 14 Bushing            | 20 Expansion plug |
| 3 Steel disk          | 9 Retaining ring   | 15 High-range gear    | 21 Range shaft    |
| 4 Clutch drive piston | 10 Ring drive gear | 16 Thrust washer      | 22 Key            |
| 5 Seal                | 11 Retaining ring  | 17 Bearing            | 23 Piston ring    |
| 6 Seal                | 12 Bushing         | 18 Reverse drive gear | 24 Race           |

Figure 198. Range clutch assembly, exploded view.

(d) Remove the retaining ring (7), backing plate (8), nine friction disks (10), and eight steel disks (9)

from each side of the splitter clutch drum (15).

(e) Press the sleeve bearing (11) from



MSC 3805-201-15/199

1 Plug	6 Breather	11 Tie rod and lockwasher	14 Rod packing
2 Dump valve spool	7 Gasket	12 Piston and rod	15 Jam nut
3 Spring	8 Tube	13 Front head and bushing	16 Lockplate
4 Dump valve body	9 Piston packing		17 Actuating valve spool
5 Connector	10 Rear head		18 Preformed packing

Figure 199. Dump valve, cross-sectional view.

- each side of the splitter clutch assembly.
- (f) Remove the two retaining rings (12) from the splitter shaft assembly (22); remove the clutch piston (13), clutch drive piston (16), and splitter shaft from the clutch drum.
- (g) Remove the seal (14) from the clutch piston and from the clutch drive piston.
- (h) Remove the four backup rings (20) and three seals (21 and 24) from the splitter shaft.
- (6) Disassemble the range clutch assembly as follows:
  - (a) Remove the three piston rings (23, fig. 198) from the range shaft assembly as shown in figure 196.
  - (b) Use a bearing puller to remove the inner race (24, fig. 198) of the bearing (17), thrust washer (16), reverse drive gear assembly (18), and low-range gear assembly (19).
  - (c) If damaged or excessively worn, remove the bushing (12) from the reverse drive gear (18), or the bushings (14) from the low-range gear (19).
  - (d) Use a bearing puller to remove the inner race (24) of the bearing (17), thrust washer (16), high-range gear assembly, and forward drive gear assembly.
  - (e) If damaged or excessively worn, remove the two bushings (14) from the high-range gear (15), or the bushing (12) from the forward drive gear (13).
  - (f) From each end of the range clutch drum (7), remove the ring drive gear (10), retaining ring (9), backing plate (1), seven friction disks (2), and six steel disks (3).
  - (g) Remove the two retaining rings (11) that retain the clutch piston (8) and clutch drive piston (4) on the range shaft (21).
  - (h) Support the inner hub of the clutch piston under the press supports; press the range shaft assembly until the key (22) is free of the clutch piston and clutch drive piston. Remove the range shaft and key.
  - (i) Remove the clutch piston, clutch drive piston, and seal (6) from the range clutch drum; remove the seal (5) from each piston.
- (7) Remove and disassemble the dump valve assembly as follows:
  - (a) Remove the hose assembly and elbow from the dump valve assembly.
  - (b) Remove the six capscrews (18, fig. 188) and lockwashers (17) that secure the dump valve assembly (16) to the transmission housing mani-

- fold; remove the dump valve assembly and gasket (15).
- (c) Release the lockplate (16, fig. 199); hold the connector (5) and unscrew the dump valve body (4) from the connector. Carefully slide the dump valve body from the actuating valve spool (17), spring (3), and dump valve spool (2); remove the dump valve spool and spring.
  - (d) Remove the plug (1) from the end of the dump valve body; remove the preformed packing (18) from the plug.
  - (e) Remove the two tie rods and lockwashers (11) that secure the rear head (10) and tube (8) to the front head and bushing (13); remove the rear head and gasket (7). Carefully slide the tube from the piston and rod (12).
  - (f) Unscrew the actuating valve spool (17) from the piston and rod, taking care not to mar the machined surfaces; remove the actuating valve spool and the piston and rod. Remove the two piston packings (9) from the piston.
  - (g) Loosen the jamnut (15); remove the connector (5), jamnut, breather (6), and gasket (7) from the front head and bushing. Use a hooked wire to remove the rod packing (14) from inside the front head and bushing.
- (8) Remove and disassemble the control valve assembly as follows:
- (a) Remove the dump valve assembly from the transmission as directed in paragraph 7(a) and (b) above.
  - (b) Remove the hose (23, fig. 188) and elbow (24) from the control valve (26). Remove the 14 screws (25) that secure the control valve assembly to the transmission housing; remove the control valve assembly and gasket (27).
  - (c) Carefully lift off and remove the adapter plate (28) and gasket (29).
  - (d) Remove the overpressure spring (30) and bearing ball (33), and lubrication valve (31) and spring (32).
  - (e) Remove the six screws (18, fig. 200) and lockwashers that secure the plate (17) to the valve body (3); remove the plate, gasket (16), spring (1), and pressure regulator valve spool (2).
  - (f) Remove the two plugs (8), washers (7), springs (5), and bearing balls (6) from the control valve. Carefully push the selector valve spool (14) and the forward and reverse valve spool (15) through the cover (12) so that they can be pulled from the plate end of the valve body; remove the remaining two bearing balls (6) and springs (5).
  - (g) Remove the retaining ring (19) from each of the valve spools.
  - (h) Remove the six screws (10 and 11) and lockwashers that secure the cover (12) to the valve body; remove the cover and gasket (9).
  - (i) Pull the stop valve (4) from its bore in the valve body.
  - (j) Remove the two seal assemblies (13) from the control valve cover.
- d. *Cleaning and Inspection.*
- (1) Clean all metallic parts with an approved cleaning solvent; take care that parts with machined surfaces are not nicked or scratched. Dry thoroughly with compressed air, but avoid spinning the bearings.
  - (2) Apply a light coating of clean machine oil to the bearings.
  - (3) Thoroughly clean all the oil passages in the transmission housing and shafts with compressed air; inspect for cracks, distortion, or other damage.
  - (4) Carefully remove all particles of old gaskets from machined surfaces.
  - (5) Inspect all parts for cracks, corrosion, pitting, stripped threads, or other damage.
  - (6) Inspect the bearings for nicks, scoring, excessive looseness, or binding operation.
  - (7) Inspect the gears and splines for chipped, broken, or excessively worn teeth, and other damage.
  - (8) Inspect all shafts, bushings, thrust washers, and other contact surfaces for scoring or excessive wear.

- (9) Inspect all springs for cracks, distortion, or loss of tension.
- (10) Replace all gaskets, seals, lockwire, and preformed packings. Replace all other unserviceable parts.

*e. Reassembly.*

- (1) Reassemble and install the control valve assembly as follows:

- (a) Install the two seal assemblies (13, fig. 200) on the control valve cover (12).
- (b) Position the stop valve (4), with the smooth face outward, in the bore of the control valve body (3).
- (c) Position the gasket (9) and assembled cover and seals on the valve body; secure with the six screws (10 and 11) and lockwashers.
- (d) Install the retaining ring (19) on the selector valve spool (14) and on the forward and reverse valve spool (15).
- (e) Carefully slide the forward and reverse valve spool part way into its bore in the valve body; position a spring (5) and bearing ball (6) in the poppet bore of the valve cover; push the valve spool until the bearing ball seats in one of the grooves. Install a second bearing ball and spring; secure with the plug (8) and washer (7).
- (f) Assemble the selector valve spool and the remaining two springs, bearing balls, one washer, and plug in the same manner as in (e) above.
- (g) Position the pressure regulator valve spool (2), spring (1), gasket (16), and plate (17) on the valve body; secure with the six screws (18) and lockwashers.
- (h) Position the spring (32, fig. 188) and lubrication valve (31) on the transmission housing. Position the bearing ball (33) and spring (30) in the recess provided in the housing. Position the gasket (29), adapter plate (28), gasket (27), and assembled control valve (26) on the transmission housing; secure with the 14 capscrews (25). Tighten the screws evenly and alternately to a torque of 15 to 17 foot-pounds.

- (2) Reassemble and install the dump valve assembly as follows:

*Note.* Lubricate the contact surfaces of the moving parts and the packings with a light film of oil at reassembly. Make sure the packings are not twisted and are facing in the proper direction.

- (a) Install the rod packing (14, fig. 199) inside the front head and bushing (13), with the lip toward the bushing. Install the jamnut (15), connector (5), breather (6), and gasket (7) on the front head and bushing.
- (b) Install the two piston packings (9) in the grooves of the piston and rod (12), with the lips toward the end of the piston. Carefully slide the piston rod through from the bushing side of the front head and bushing to prevent damaging or dislodging the rod packing; install the actuating valve spool (17) on the threaded end of the piston rod.
- (c) Position the remaining gasket (7) on the rear head (10). Slide the tube (8) over the piston against the front head and bushing. Aline the rear head with the tube and front head; secure with the two tie rods and lockwashers (11). Tighten the tie rods and lockwashers evenly, putting them under slight tension.
- (d) Position the spring (3) and the dump valve spool (2) on the actuating valve spool; position the lockplate (16) on the connector. Slide the valve spools into the bore of the dump valve body (4) from the end that does not have a side connection; screw the dump valve body securely on the connection and bend the tab of the lockplate. Aline the breather with the side connection on the dump valve body; tighten the jamnut.
- (e) Position the preformed packing (18) on the plug (1); install the plug into the end of the dump valve body.
- (f) Position the gasket (15, fig. 188) and the assembled dump valve (16) on the transmission housing mani-

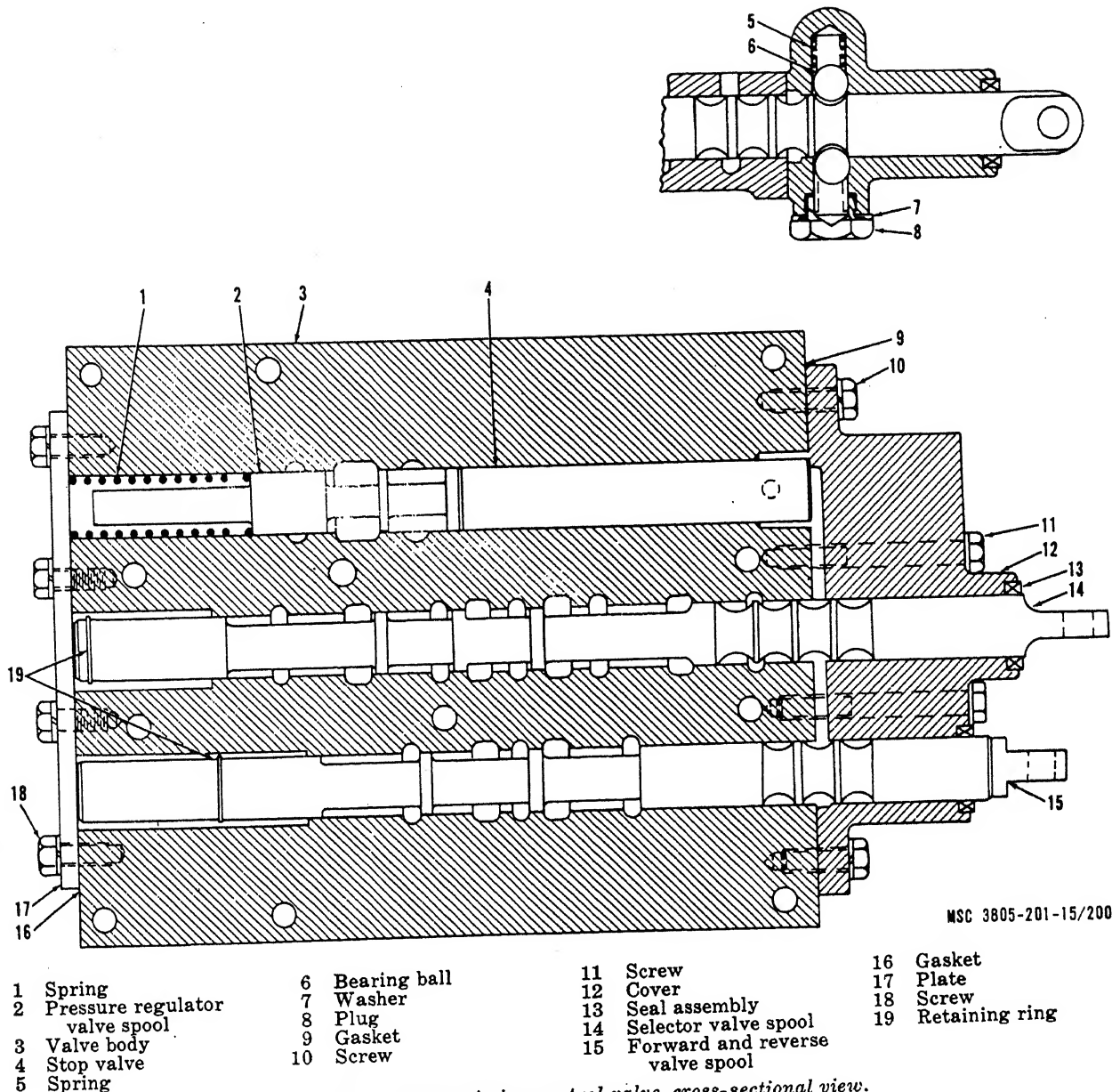


Figure 200. Transmission control valve, cross-sectional view.

fold; secure with the six capscrews (18) and lockwashers (17). Tighten the screws to a torque of 15 to 17 foot-pounds.

- (g) Install the nipple (20), tee (21), and bushing (22) on the dump valve body.

*Note.* Lubricate the parts of the clutch assemblies with clean transmission hydraulic fluid to facilitate reassembly.

- (3) Reassemble the forward and reverse clutch assembly as follows:

- (a) Position the eight springs (16, fig.

195) and spring guides (15) in the holes on each side of the forward and reverse clutch drum (17); secure with the spring retaining plates (14) and screws (13); make sure that all spring guides are free to move in their bores.

- (b) Install the seal (18) in the groove of the clutch piston (19), and the seal (11) in the groove of the clutch drive piston (10).

- (c) Position the key (25) on the forward and reverse shaft (24); aline

- the slot of the clutch piston with the key and install the clutch piston on the shaft assembly. Position the thrust washer (9) on the shaft and install the retaining ring (8) on the shaft assembly.
- (d) Position the seal (12) on the clutch drive piston.
  - (e) Carefully install the assembled shaft assembly and clutch piston into the clutch drum; aline the slot of the clutch drive piston with the key. Install the clutch drive piston over the shaft assembly into the clutch drum; secure with the thrust washer (9) and retaining ring (8).
  - (f) Alternately position six friction disks (7) and five steel disks (6) into the clutch drum. Position the backing plate (5) in the clutch drum; secure with the retaining ring (4). Assemble the remaining six friction disks and five steel disks into the opposite side of the clutch drum; secure with the remaining backing plate and retaining ring.
  - (g) If removed, press the two bushings (27) into position in the reverse drive gear (3); press the two bushings (23) into position in the forward drive gear (20). Ream the bushings to 2.0012-inch diameter.
  - (h) Position the assembled reverse drive gear (3) and bushings over the piston ring end of the shaft assembly; rotate the gear slightly to obtain alinement of the gear with the friction disks. Install the input gear (2) on the shaft assembly with the bearing surface outward.
  - (i) Position the assembled forward drive gear (20) and bushings on the shaft assembly; rotate the gear slightly to obtain alinement of the gear with the clutch friction disks. Position the thrust washer (21) on the shaft assembly; install the inner race of the bearing (22).
  - (j) Install the three piston rings (26) into the grooves of the shaft assembly.
  - (4) Reassemble the splitter clutch assembly as follows:
    - (a) Install a seal (14, fig. 197) on the clutch piston (13) and clutch drive piston (16).
    - (b) Install the four backup rings (20) and three seals (21 and 24) on the splitter shaft (22).
    - (c) Position the clutch piston (13), with the seal edge inward, on the splitter shaft assembly from the piston ring end; secure with the retaining ring (12).
    - (d) Position the assembled shaft and clutch piston in the clutch drum (15). Position the clutch drive piston (16), with the seal edge inward, on the splitter shaft assembly; secure with the retaining ring (12).
    - (e) Press the sleeve bearing (11) into position on each end of the splitter shaft assembly.
    - (f) Alternately position nine friction disks (10) and eight steel disks (9) into the clutch drum; secure with the backing plate (8) and retaining ring (7). Assemble the remaining nine friction disks, eight steel disks, backing plate, and retaining ring into the opposite end of the clutch drum in the same manner.
    - (g) Install the retaining rings (6) on the high-splitter gear (5) and low-splitter gear (17).
    - (h) From the piston ring end of the splitter shaft assembly, install the high-splitter gear over the sleeve bearing, turning it as required to aline the splines with the friction disks; position the thrust washer (4) on the shaft and secure with the retaining ring (3).
    - (i) Position the low-splitter gear (17) over the sleeve bearing on the splitter shaft assembly, turning the gear as required to obtain alinement of the splines with the friction disks.
    - (j) Install the high-range gear (18); press the inner race of the roller bearing (19) on the splitter shaft assembly.
    - (k) Install the three piston rings (23) into the grooves of the splitter shaft assembly.



(5) Reassemble the range clutch assembly as follows:

- (a) Install a seal (5, fig. 198) on the clutch piston (8) and on the clutch drive piston (4).
- (b) Position the key (22) on the range shaft assembly (21). Aline the slot of the clutch drive piston with the key and slide the piston into position from the piston ring end of the range shaft assembly; secure with the retaining ring (11).
- (c) Position the seal (6) on the clutch drive piston.
- (d) Position the assembled range shaft assembly and clutch drive piston in the clutch drum (7). Aline the slot of the clutch piston (8) with the key and slide the clutch piston into position on the range shaft assembly; secure with the retaining ring (11).
- (e) Alternately position seven friction disks (2) and six steel disks (3) into the clutch drum; secure with the backing plate (1) and retaining ring (9). Assemble the remaining seven friction disks, six steel disks, backing plate, and retaining ring into the opposite end of the clutch drum in the same manner.
- (f) If removed, install the wiper on each of the ring drive gears (10).
- (g) Install each of the two ring drive gears into the clutch drum; turn the ring drive gear as required to obtain alinement of the splines with the clutch friction disks.
- (h) If they were removed, press the two bushings (14) into the high-range gear (15); press the two bushings (14) into the low-range gear (19); press the bushing (12) into the reverse drive gear (18); and press the bushing (12) into the forward drive gear (13).
- (i) Position the reverse drive gear (18) over the piston ring end of the range shaft assembly and aline the splines with the clutch drum (7).
- (j) Position the low-range gear (19) on the range shaft assembly; turn the gear, if required, to aline the

splines with the ring drive gear (10). Position the thrust washer (16); press the inner race of the bearing (17) on the range shaft assembly.

- (k) Position the forward drive gear (13) over the range shift assembly and aline the splines with the clutch drum.
  - (l) Position the high-range gear (15) on the range shaft assembly (21); turn the high-range gear, if required, to aline the splines with the ring drive gear (10). Position the thrust washer (16); press the inner race of the bearing (17) on the end of the range shaft assembly.
- (6) Reassemble the clutch section of the transmission as follows:
- (a) Position the reverse idler shaft (101, fig. 188) in the transmission housing (34); secure with the cap-screw (99) and washer (100). Tighten the screw to a torque of 310 to 330 foot-pounds.
  - (b) If removed, press a new large bushing (27, fig. 193) and small bushing into the front output shaft (28); press a bushing (29) into each end of the high-output gear (30).
  - (c) Position the high-output gear, small diameter end first, on the front output shaft; position the spacer (31) on the shaft.
  - (d) If removed, install the ball bearings in their respective positions in the transmission housing. Install the seals (8 and 10) in the transmission housing.
  - (e) Position the low-range gear (2, fig. 197) on the roller bearing in the transmission housing.
  - (f) Position the assembled front output shaft and the high-output gear in the transmission housing.
  - (g) Start the shift shaft (11, fig. 193), with the eye end outward, into its bore on the transmission housing; position the spring (13) and bearing ball (12) in the poppet hole and retain by pushing the shift shaft farther in until the bearing ball seats

in one of the grooves of the shift shaft.

- (h) Position the remaining bearing ball (12) and spring (13); retain with the clamp (14). Secure the clamp with the two screws (15); lock with the lockwire (16).
- (i) Install the retaining ring (38, fig. 188) in the bore of the reverse idler gear (39). Press the bearing cups (37) into the reverse idler gear.

*Note.* Use clean grease to hold the three piston rings centered during installation of each of the clutch assemblies.
- (j) Install the bearing cone (36) on the reverse idler shaft (101). Install the forward and reverse clutch assembly (43); at the same time, position the reverse idler gear (39) on its shaft. Install the second bearing cone (36) on the reverse idler shaft. Secure the gear to the shaft with a washer (40) and two capscrews (41). Install a shim (102) of a thickness that will prevent end play of the gear (39). When proper shim thickness is installed, secure the capscrews (41) with the lockwire (42).
- (k) Install the splitter clutch assembly (45) into the transmission housing; rotate the low-range gear, if required, to obtain alinement with the splines of the clutch shaft.
- (l) Install the range clutch assembly (44) into the transmission housing as shown in figure 191.
- (m) Position the shift sleeve (26, fig. 193), with the V-grooved side outward, over the high-output gear.
- (n) Engage the shift fork (17) with the groove of the shift sleeve and position over the end of the shift shaft; aline the hole in the shift shaft with the threaded hole of the shift fork. Install the setscrew (18) on the shift fork; lock with the lockwire (19).
- (o) Press the two bushings (24) into the low-output gear (20).
- (p) Position the low-output gear, with small diameter first, and the thrust washer (21) on the rear output shaft (25); press the ball bearing (22) on the rear output shaft.

- (q) Aline the gear teeth and position the assembled rear output shaft and low-output gear over the front output shaft in the transmission housing.
- (r) Position the baffle (62, fig. 188) and screen assembly (63) on the suction tube in the transmission housing; secure the baffle and screen assembly by tightening the setscrew.
- (s) If the bearings were removed, install the roller bearings into their respective positions in the transmission housing rear cover (49).
- (t) Position the gasket (46) on the transmission housing; carefully lower the assembled housing rear cover and bearings into position; secure with the 19 capscrews (48) and lockwashers (47). Tighten the screws evenly and alternately to a torque of 26 to 29 foot-pounds.
- (u) Install the seal (52) in the brake adapter housing (51).
- (v) Position the spacer (23, fig. 193) on the rear output shaft.
- (w) Position the gasket (50, fig. 188), assembled brake adapter housing and seal, and the brake backing plate on the transmission housing rear cover; secure with the seven screws and lockwashers.
- (x) Aline the splines and install the output flange (53) and the preformed packing (54) on the rear output shaft; secure with the washer (56), two capscrews (57), and two seal rings (55). Secure the screw with the lockwire (58).
- (y) Reassemble the parking brake as directed in paragraph 196c.
- (z) Install the plug on the transmission housing.
- (aa) If removed, install the slinger (7, fig. 193) on the flange (6).
- (ab) Turn the transmission to an upright position on a stand or suitable blocking.
- (ac) Install the output flange (6), preformed packing (5), and slinger (7) on the front output shaft (28); secure with the washer (3), two screws (2), and two seal rings (4).

Secure the screws with the lockwire (1). Bend up the corners of the retainer to lock the screws.

(7) Reassemble the torque converter section of the transmission as follows:

- (a) Press the ball bearing (9, fig. 188) into position on the input gear (13); secure with the retaining ring (8).
- (b) Press the assembled ball bearing and input gear on the ground sleeve (5); secure with the retaining ring (10).
- (c) Install the oil ring (11) in the groove of the turbine shaft assembly (12). Install the turbine shaft through the ground sleeve, taking care to align the splines with the splines of the input gear; secure with the retaining ring (14).
- (d) Install the oil ring (4) on the ground sleeve.
- (e) Position the assembled ground sleeve, turbine shaft, and input gear so the holes are aligned with the tapped holes in the housing; secure with the five capscrews (6) and lockwashers (7). Tighten the screws to a torque of 26 to 29 foot-pounds.
- (f) Press the ball bearing (97) into position on the accessory drive shaft (98), with the grooved side toward the gear; secure with the retaining ring (96).
- (g) Position the assembled accessory drive shaft and bearing in the transmission housing. Engage the bearing retainer clip (93) into the groove of the bearing; secure by installing the capscrew (95) and lockwasher (94) through one of the openings in the accessory drive shaft gear.
- (h) Install new screws (65) to replace any that have been removed from the converter pump (66).
- (i) Press the ball bearing (2) on the accessory drive gear (3).
- (j) Press the assembled bearing and accessory drive gear onto the converter pump (66); secure with the six capscrews (71) and flat washers (69). Tighten the screws to a torque

of 20 to 25 foot-pounds; lock with the lockwire (70).

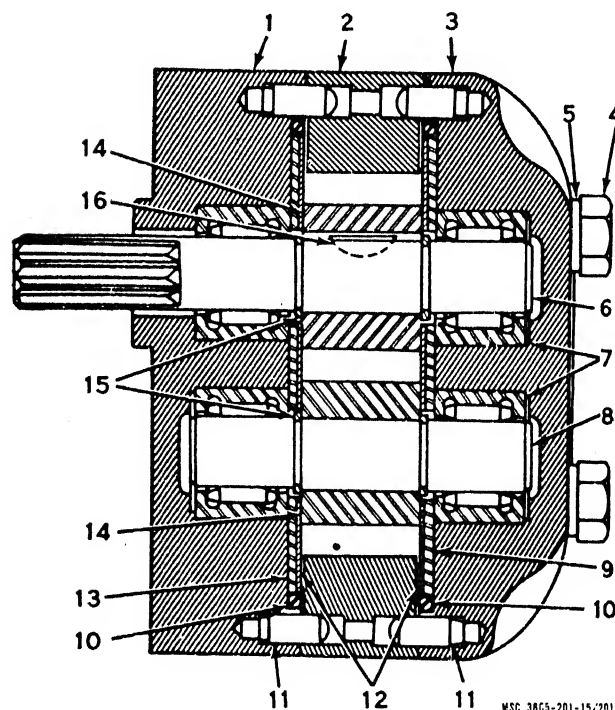
- (k) Position the assembled converter pump and accessory drive gear on the ground sleeve, taking care not to damage the oil ring; secure with the retaining ring (1).
- (l) Position the spacer (67) and the reaction member (68), with the rounded edge of the blade upward on the ground sleeve; secure with the retaining ring (72).
- (m) Install a retaining ring (73) on the turbine shaft. Position the turbine (74) on the turbine shaft; secure with the second retaining ring (75).
- (n) Align the index marks and position the cover (76) on the converter pump; secure with the 24 nuts (78) and lockwashers (77). Tighten the nuts evenly and alternately to a torque of 22 to 24 foot-pounds. Install the plug (64) on the converter pump.
- (o) If removed, install the bushing (79) on the converter input shaft (92).
- (p) Press the ball bearing (81) into position on the converter input shaft. Position the assembled converter input shaft and bearing on the cover (76); secure with the six capscrews (80). Tighten the screws to a torque of 38 to 42 foot-pounds.
- (q) Install the seal (87) on the converter housing cover (84). Position the gasket (82) and the converter housing cover, with the drain plug opening toward the bottom of the transmission housing; secure with the 12 capscrews (86) and lockwashers (85). Tighten the screws to a torque of 22 to 24 foot-pounds.
- (r) Install the input flange (88) on the converter input shaft; secure with the washer (89), two capscrews (90), and the lockwire (91). Tighten the screws to a torque of 35 to 40 foot-pounds; bend up the corners of the retainer to lock the screws.
- (s) Install the plug (83) on the converter housing cover.

- (8) Assemble the pump drive housing onto the transmission as follows:
  - (a) Press the ball bearing (16, fig. 187) into position on the driven gear (15).
  - (b) If removed, press a new seal wiper (13) into position on the driver gear (9).
  - (c) Install the retaining ring (6) into the inner groove of the bore of the driver gear; install the spline seal plug (7).
  - (d) Press the ball bearings (8) into position on each side of the driver gear.
  - (e) Position the front pump drive housing (1) and gasket on the transmission; secure with the four screws (3) and lockwashers (2). Tighten the screws to a torque of 64 to 71 foot-pounds.
  - (f) Install the assembled driven gear and bearing into position on the front pump drive housing; aline the gear teeth and press the assembled driver gear, bearings, and plug, with the wiper outward, into position on the front pump drive housing.
  - (g) Install the seal (14) on the rear pump drive housing (10).
  - (h) If they were removed, install the two dowel pins (4) on the front pump drive housing.
  - (i) Position the rear pump drive housing on the front pump drive housing; secure with the 16 screws (12) and lockwashers (11). Tighten the screws to a torque of 20 to 25 foot-pounds.

*f. Installation.*

- (1) Move the transmission under the loader and raise into position using suitable jacks or dollies; secure to each of the two mounting brackets with the four screws and lockwashers.
- (2) Install the lower drive shafts as directed in paragraph 217e.
- (3) Install the upper drive shaft as directed in paragraph 216c.
- (4) Install and connect the leads to the torque converter temperature senders (7, fig. 103) and switch (8).

- (5) Install the torque converter and charging pump as directed in paragraph 214c.
- (6) Install the main hydraulic pump as directed in paragraph 206c.
- (7) Position the clevis of the bellcrank-to-transmission rod (24, fig. 76) on the transmission shift shaft; secure with a clevis pin (21) and cotter pin (20).
- (8) Connect the linkage to the transmission control valve as directed in paragraph 172d.
- (9) Connect the brake treadle valve-to-dump valve tube to the dump valve.
- (10) Connect the 90° nipple (5, fig. 103) to the cross (6) on the torque converter housing cover; connect the tube (9) to the straight adapter on the transmission housing.
- (11) Fill the torque converter and transmission lubrication system as directed in paragraph 212.



1 Adapter	9 Wear plate
2 Housing	10 Preformed packing
3 Cover	11 Dowel pin
4 Screw	12 Shim
5 Flat washer	13 Wear plate
6 Drive shaft	14 Gear
7 Roller bearings	15 Retaining ring
8 Driven shaft	16 Key

Figure 201. Torque converter charging pump, cross-sectional view.

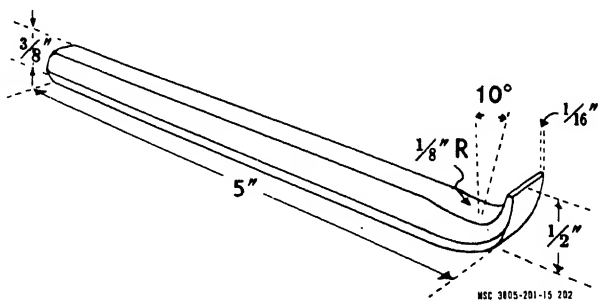


Figure 202. Bearing removal prying tool.

- (12) Remove the blocking from the wheels; check the transmission operation in each speed and direction.

## 258. Torque Converter Charging Pump

*a. General.* The torque converter charging pump is a single-stage positive-displacement gear pump mounted on the transmission and driven through a series of gears by the accessory drive shaft. The pump draws oil from the transmission sump and supplies oil under a pressure of 225 to 240 psi to the transmission control valve for actuation of the clutches. Rotation of the pump is counterclockwise when facing the drive end.

### *b. Removal and Disassembly.*

- (1) Remove the torque converter charging pump as directed in paragraph 214a.
- (2) Wipe all grease and dirt from the exterior of the pump with a cloth dampened with an approved cleaning solvent. Take care that no foreign matter enters the openings of the adapter.
- (3) Index the cover (3, fig. 201) and adapter (1) to the housing (2) with a punch to facilitate reassembly.
- (4) Remove the four screws (4) and flat washers (5) that secure the cover and housing to the adapter; if necessary, tap lightly with a soft hammer to separate the parts. **DO NOT USE A SCREWDRIVER TO PRY APART.**
- (5) Remove the cover (3), shims (12), housing (2), remaining shims, assembled driven shaft and gear, and assembled drive shaft and gear from the adapter.
- (6) Remove the two retaining rings (15) from the driven shaft (8); press the driven shaft from the gear (14).
- (7) Remove the two retaining rings (15) from the drive shaft (6); press the

drive shaft from the gear (14) and remove the key (16).

- (8) If loose or damaged, remove the two dowel pins (11) from the cover and from the adapter.
- (9) Remove the wear plate (9) and pre-formed packing (10) from the cover; remove the wear plate (13) and pre-formed packing (10) from the adapter.
- (10) If the roller bearings (7) in the cover or adapter are worn excessively or damaged, remove the roller bearings as follows:
  - (a) Start the roller bearing from its bore by inserting a tool made as shown in figure 202 through the bearing and tapping the upper end with a hammer as shown in figure 203.
  - (b) Insert a puller tool made as shown in figure 204 through the bearing and hook under the inner race.
  - (c) Tap the puller tool with a heavy bar as shown in figure 205 to remove the roller bearings.

### *c. Cleaning and Inspection.*

- (1) Thoroughly clean the parts by washing with an approved cleaning solvent; dry with compressed air.

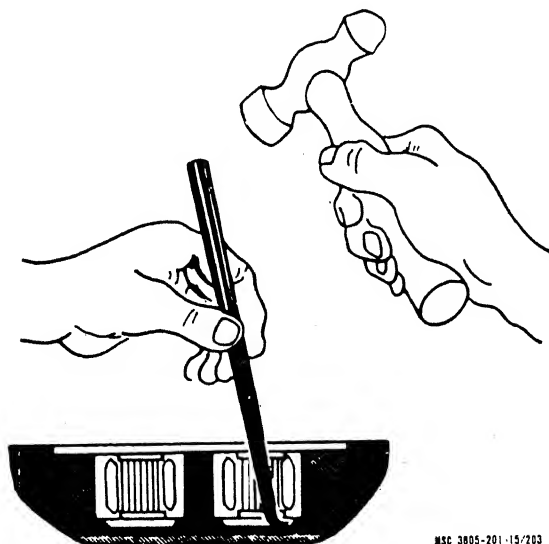


Figure 203. Starting bearing removal.

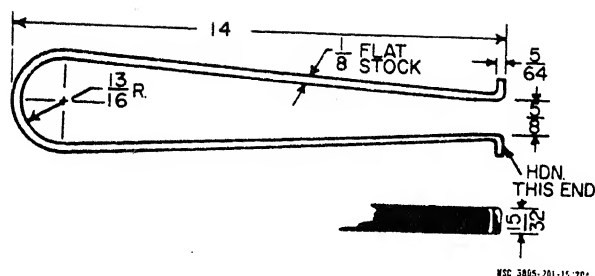


Figure 204. Bearing removal tool.

- (2) Inspect the wear plates for damage or excessive wear; replace if severely scored or if there is an erosion path in the vicinity of the counterbored relief pocket.
- (3) Inspect the shafts for damage or excessive wear; replace if wear at the roller patterns exceeds 0.001 inch from that of the major diameter of the shafts.
- (4) Inspect the roller bearings for cracks, pitting, binding operation, or wear that allows a 0.020-inch feeler gage to be inserted between the rollers.
- (5) Inspect the gears for cracked, chipped, scored, or excessively worn gear teeth. Replace both gears if the differential between the housing width and gear width with no gaskets is more than 0.0035 inch.
- (6) Inspect the housing for cracks, scoring, or other damage. Replace if damaged or if the gear bores measure more than 3.259-inch inside diameter through the dowel pin hole centerline.
- (7) Replace the preformed packings and all unserviceable parts.

#### d. Reassembly and Installation.

- (1) If the roller bearings (7, fig. 201) have been removed from the cover (3) or adapter (1), lubricate with light grease and press the new roller bearings into position with a tool as shown in figure 206.
- (2) Install a retaining ring (15, fig. 201) in the groove of the drive shaft (6) that is nearest the splines. Coat the interior of the gears (14) with white lead. Position the key (16) on the drive shaft. Align the slot of the gear with the key and press the gear into

place; install the second retaining ring (15) on the drive shaft.

- (3) Install a retaining ring (15) in one of the grooves of the driven shaft (8). Press the gear on the shaft against the retaining ring; install the remaining retaining ring on the driven shaft.
- (4) If they were removed, install the two dowel pins (11) in the cover (3) and in the adapter (1).
- (5) Position the preformed packing (10) and the wear plate (13) on the adapter so that the counterbored relief pocket is toward the gears.
- (6) Measure the width of the housing (2) and the width of the gears (14); select the proper shims (12) as indicated on the clearance chart.

CLEARANCE CHART

Gear width greater (+) or less (—) than housing width	Shims required	
	Adapter side	Cover side
+0.002	0.002	0.002
+0.001	0.001	0.002
0.000	0.001	0.001
—0.001	—	0.001
—0.002	—	—

#### SHIM COLOR CODE:

0.001—Amber      0.002—Red      0.0015—Purple

- (7) Position the assembled gear and driven shaft and the assembled gear and drive shaft on the adapter; lightly lubricate the gears and shafts with clean lubricating fluid.

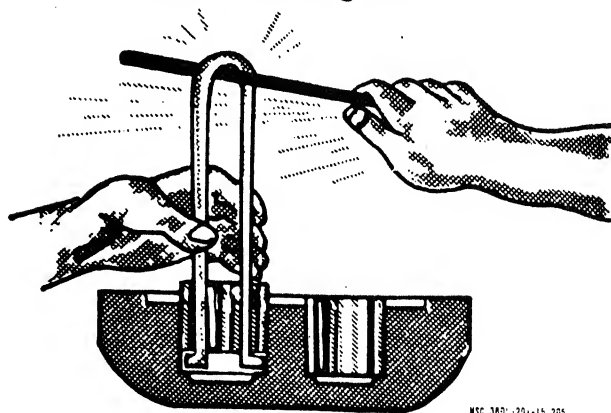


Figure 205. Removing bearings.





lic cylinder; remove the brakeshoes and flat washers (10).

- (8) If the linings are unserviceable, remove the 16 rivets (15) that secure each lining (14) to its brakeshoe (16).
- (9) If the brakeshoe bushings (17) are excessively worn or damaged, press the bushings from the shoes.
- (10) Remove the pin (13) from the brakeshoe if loose or damaged.
- (11) Remove the retaining ring (19) from each anchor pin (20); remove the anchor pins from the brake spider (8).
- (12) If damaged, remove the adjusting cam (25) by grinding off the swaged end of the adjusting cam bolt (28); remove the spring (26), washer (27), and adjusting bolt.
- (13) If replacement of the brakeshoe guide pins (9) is required, center-punch and drill out the end; carefully drive the pins from the brake spider.

*c. Cleaning and Inspection.*

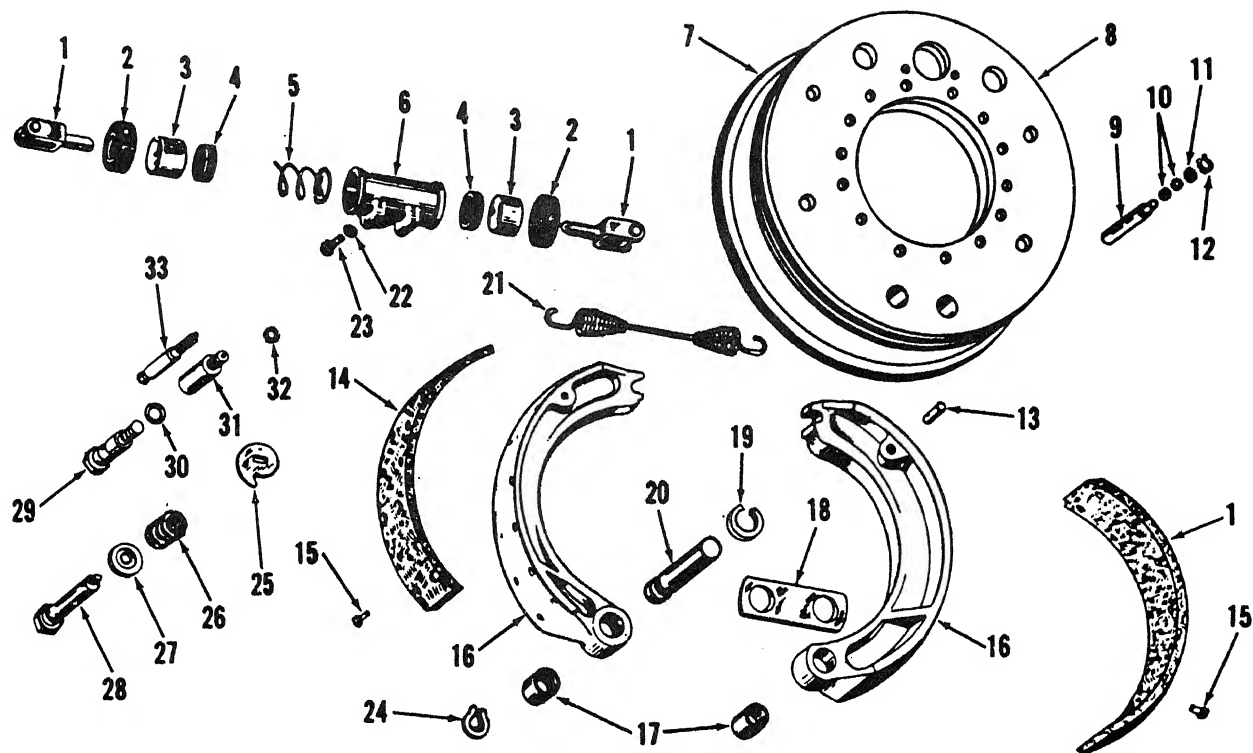
- (1) Clean all metallic parts with an approved cleaning solvent; dry with compressed air.
- (2) Wipe all dirt from the brakeshoe assemblies; brush the linings with a wire brush.
- (3) Inspect the linings for oil or grease contamination, loose rivets, or wear of linings to the extent that the rivet heads are near the outer surface; replace excessively worn or defective linings.
- (4) Inspect the brake drum for cracks, scoring, or excessive wear. Turn down a slightly worn or scored brake drum by taking light cuts with a lathe; do not remove any more metal than required. If badly scored or damaged, replace the brake drum.
- (5) Inspect the springs for cracks, distortion, or loss of tension.
- (6) Inspect the brakeshoes for cracks, distortion, or damage.
- (7) Inspect all other parts for excessive wear, distortion, or stripped threads; replace unserviceable parts.

*d. Reassembly.*

- (1) If the guide pins (9) were removed, position the new guide pins on the

brake spider (8); stake securely in place.

- (2) Position the washer (27) on the adjusting cam bolt (28). Insert the adjusting bolt through the brake spider and position the spring (26) and adjusting cam (25); swage the end of the adjusting bolt to secure the parts.
- (3) Press the two anchor pins (20) into position on the brake spider; secure each with a retaining ring (19).
- (4) If the linings were removed, position a lining (14) on each of the brakeshoes (16); secure the linings with the rivets (15).
- (5) If the bushings (17) were removed from the brakeshoes, press new bushings into place. Install the pins (13) on the brakeshoes.
- (6) Position a flat washer (10) on each guide pin.
- (7) Position the brakeshoe and lining assemblies over the anchor pins and guide pins; secure with a flat washer (10), spring washer (11), and C washer (12) on each guide pin and link (18), and two C washers (24) on the anchor pins (20).
- (8) Position the gasket (30), inlet connection (31), and gasket (32) on the fluid passage bolt (29). Install the inlet connection and the bleeder screw (33) in the hydraulic cylinder.
- (9) Position the assembled hydraulic cylinder on the brake spider (8); secure with the two screws (23) and lockwashers (22).
- (10) Engage the ends of the brakeshoes with the yoke pin assemblies (1) of the hydraulic cylinders and install the spring (21) on the brakeshoes.
- (11) Install the rigid axle brake assemblies as directed in paragraph 265e; reassemble the remaining parts of the rigid axle hub.
- (12) Bleed the hydraulic brake system as directed in paragraph 186b.
- (13) Adjust the brakes as follows:
  - (a) Rotate the eccentric cams in the direction shown in figure 85 while rotating the wheel. Adjust the cams until there is a drag on the wheel. Do not back off at this time.



MSC 3805-201-15/207

1 Yoke pin assembly	10 Flat washer	19 Retaining ring	26 Spring
2 Boot	11 Spring washer	20 Brake shoe anchor	27 Washer
3 Piston	12 C washer	21 Spring	28 Adjusting cam bolt
4 Piston cup	13 Pin	22 Lockwasher	29 Fluid passage bolt
5 Spring	14 Lining	23 Screw	30 Gasket
6 Cylinder casting	15 Rivet	24 C washer	31 Inlet connection
7 Seal	16 Brake shoe	25 Adjusting cam	32 Gasket
8 Brake spider	17 Bushing		33 Bleeder screw
9 Brake shoe guide pin	18 Link		

Figure 207. Rigid axle (front) wheel brake assembly, exploded view.

- (b) Loosen the nut on the anchor pin and rotate the anchor pin sufficiently to relieve the drag.
- (c) Repeat (a) and (b) above until additional rotation of the anchor pin no longer relieves the drag; tighten the nut on the anchor pin.
- (d) Back the cam off sufficiently to permit the wheel to rotate freely.

## 260. Front Wheel Cylinder (fig. 207)

### a. Removal and Disassembly.

- (1) Disassemble the rigid axle as directed in paragraph 265c(1) through (3).
- (2) Remove the spring (21) from the brakeshoes (16).
- (3) Remove the bleeder screw (33), fluid

passage bolts (29), gaskets (30 and 32), and inlet connections (31) from the hydraulic cylinder.

- (4) Remove the two screws (23) and lockwashers (22) that secure the hydraulic cylinder to the brake spider (8); remove the assembled hydraulic cylinder.
- (5) Remove the two yoke pin assemblies (1), boots (2), pistons (3), piston cups (4), and spring (5) from the cylinder casting (6).

### b. Cleaning and Inspection.

- (1) Clean the yoke pin assemblies, cylinder castings, spring, and pistons with an approved cleaning solvent.
- (2) Inspect the hydraulic cylinder casting and piston for cracks, scoring, or pit-

ting. Use a hone to remove any burrs or slight wear.

- (3) Inspect the spring for cracks, distortion, or loss of tension.
- (4) Replace the boots, piston cups, and any other unserviceable parts.

*c. Reassembly and Installation.*

*Note.* Lubricate the hydraulic cylinder pistons, piston cups, and the interior of the cylinder casting with clean brake fluid to facilitate reassembly. Take care to prevent the entrance of dirt in the hydraulic cylinder.

- (1) Position the spring (5); two piston cups (4), with the smooth surfaces outward; pistons (3), with the flat surfaces inward; boots (2); and yoke pin assemblies (1) in the cylinder casting (6).
- (2) Position the assembled cylinder on the brake spider (8); secure with the two screws (23) and lockwashers (22).
- (3) Install the inlet connection (31) and fluid passage bolt (29) with the gaskets (32 and 30) in the cylinder. Install the bleeder screw (33) in the cylinder.
- (4) Engage the brakeshoes with the yoke pin assemblies of the hydraulic cylinder; install the brakeshoe return spring between the shoes.
- (5) Reassemble the rigid axle as directed in paragraph 265e.
- (6) Bleed the hydraulic brake system as directed in paragraph 186b.

**261. Steering Axle (Rear) Wheel Brake Assembly**  
(fig. 208)

*a. Disassembly.*

- (1) Disassemble the steering axle final drives as directed in paragraph 264c(1).
- (2) Remove the four screws (8) and lockwashers (9) that secure the dust shields (7 and 15) to the steering knuckle; remove the dust shields.
- (3) Remove the spring (10) from the brakeshoes.
- (4) Remove the two retaining rings (18) and the link (17) that secure the brakeshoes to the anchor pins; disengage the brakeshoes from the hydraulic cylinder yoke pin assemblies; remove the brakeshoes.

- (5) If the linings (13) are unserviceable, remove the 16 rivets that secure each lining to its brakeshoe (11 or 20).

- (6) If the bushings (16) are excessively worn or damaged, press the bushings from the brakeshoes. If loose or damaged, remove the pins (12) from the brakeshoes.
- (7) Remove the bleeder screw (31) from the hydraulic cylinder casting.
- (8) Remove the two screws (27) and lockwashers (28) that secure the adapter (29) to the steering knuckle; remove the assembled adapter and hydraulic cylinder.
- (9) Remove the nut (22) and lockwasher (21) that secure each anchor pin (19) to the steering knuckle; remove the anchor pins.
- (10) If damaged, remove the adjusting cam (26) by grinding off the swaged end of the adjusting cam bolt (23); remove the spring (25), washer (24), and the adjusting bolt.

*b. Cleaning and Inspection.*

- (1) Clean all metallic parts with an approved cleaning solvent; dry with compressed air.
- (2) Wipe all dirt from the brakeshoe assemblies; brush the lining with a wire brush.
- (3) Inspect the linings for oil or grease contamination, loose rivets, or lining wear to the extent that the rivet heads are near the outer surface; replace excessively worn or defective linings.
- (4) Inspect the brake drum for cracks, scoring, or excessive wear. Turn down a slightly scored brake drum by taking light cuts with a lathe; do not remove any more metal than required. If damaged or badly scored, replace the brake drum.
- (5) Inspect the brakeshoes for cracks, distortion, or damage.
- (6) Inspect the hydraulic cylinder casting and pistons for cracks, scoring, pitting, or other damage. Use a hone to remove any burrs or slight wear.
- (7) Inspect the springs for cracks, distortion, or loss of tension.
- (8) Inspect all other parts for excessive

wear, distortion, or stripped threads; replace unserviceable parts.

*c. Reassembly.*

- (1) If the adjusting cam (26) was removed, position the washer (24) on the adjusting cam bolt (23). Insert the adjusting cam bolt through the steering knuckle and position the spring (25) and adjusting cam; swage the end of the adjusting cam bolt to secure the parts.
- (2) Position the two anchor pins (19) on the steering knuckle so that the center punch marks are toward each other; secure with a lockwasher (21) and nut (22).
- (3) Position the assembled hydraulic cylinder and adapter (29) on the steering knuckle; secure with the two screws (27) and lockwashers (28).
- (4) Install the bleeder screw (31) in the cylinder.
- (5) If removed, position a lining (13) on each of the brakeshoes (11 and 20); secure the linings with the rivets (14).
- (6) If the bushings (16) were removed from the brakeshoes, press new bushings into place. Install the pins (12) on the brakeshoes.
- (7) Position the brakeshoe assemblies over the anchor pins and engage the hydraulic cylinder yoke pin assemblies; secure with the link (17) and two retaining rings (18).
- (8) Install the spring (10) on the brakeshoes.
- (9) Position the dust shields (7 and 15) on the steering knuckle; secure each with the two screws (8) and lockwashers (9).
- (10) Reassemble the steering axle final drive as directed in paragraph 264e(19).
- (11) Bleed the hydraulic brake system as directed in paragraph 186b.
- (12) Adjust the steering axle brake assemblies as directed in paragraph 186a.

## **262. Rear Wheel Cylinder** (fig. 208)

*a. Removal and Disassembly.*

- (1) Disassemble the steering axle final

drives as directed in paragraph 264c(1).

- (2) Remove the spring (10) from the brakeshoes (11 and 20).
- (3) Remove the two screws (27) and lockwashers (28) that secure the adapter (29) to the steering knuckle; remove the assembled adapter and hydraulic cylinder.
- (4) Remove the two yoke pin assemblies (1), boots (2), pistons (3), piston cups (4), and spring (5) from the hydraulic cylinder casting.
- (5) Remove the two screws (30) and lockwashers (9) that secure the cylinder casting (6) to the adapter; remove the cylinder casting.

*b. Cleaning and Inspection.* Perform the cleaning and inspection services directed in paragraph 258b.

*c. Reassembly and Installation.*

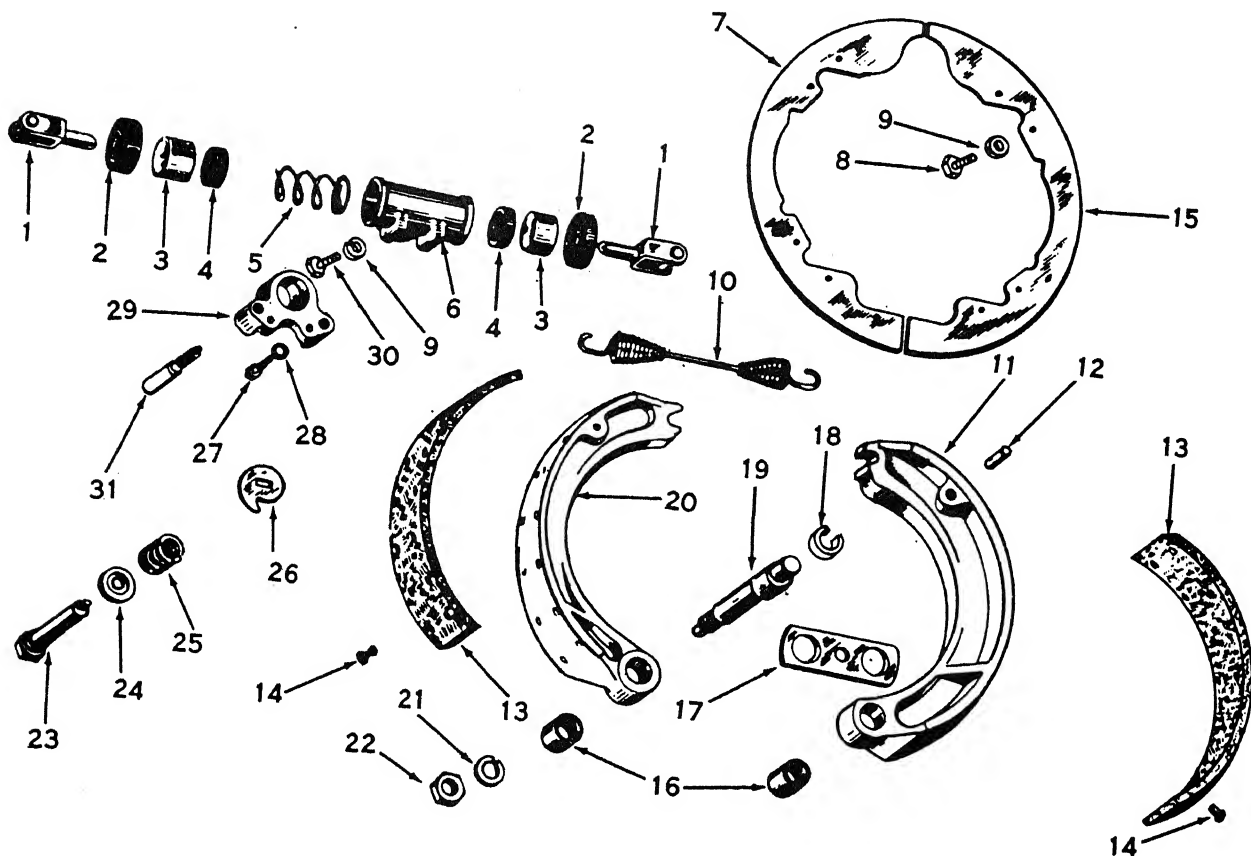
- (1) Position the hydraulic cylinder casting (6) on the adapter (29); secure with the two screws (30) and lockwashers (9).

*Note.* Lubricate the hydraulic cylinder pistons, piston cups, and the interior of the cylinder casting with clean brake fluid to facilitate reassembly. Take care to prevent the entrance of dirt into the hydraulic cylinder.

- (2) Position the spring (5); two piston cups (4), with the smooth surface outward; pistons (3), with the smooth surface inward; boots (2); and yoke pin assemblies (1) in the cylinder casting (6).
- (3) Position the assembled cylinder and adapter on the steering knuckle; secure with the two screws (27) and lockwashers (28).
- (4) Install the spring (10) between the brakeshoes (11 and 20).
- (5) Reassemble the steering axle final drive as directed in paragraph 264e(19).
- (6) Bleed the hydraulic brake system as directed in paragraph 186b.

## **263. Steering Gear**

*a. General.* The steering gear incorporates a hydraulic control valve with a mechanical steering gear. Whenever the driver's effort at the steering wheel exceeds the preload of the center-



MSC 3805-201-15/208

- |                     |                |                       |                  |
|---------------------|----------------|-----------------------|------------------|
| 1 Yoke pin assembly | 9 Lockwasher   | 17 Link               | 25 Spring        |
| 2 Boot              | 10 Spring      | 18 Retaining ring     | 26 Adjusting cam |
| 3 Piston            | 11 Brake shoe  | 19 Anchor pin         | 27 Screw         |
| 4 Piston cup        | 12 Pin         | 20 Brake shoe         | 28 Lockwasher    |
| 5 Spring            | 13 Lining      | 21 Lockwasher         | 29 Adapter       |
| 6 Cylinder casting  | 14 Rivet       | 22 Nut                | 30 Screw         |
| 7 Dust shield       | 15 Dust shield | 23 Adjusting cam bolt | 31 Bleeder screw |
| 8 Screw             | 16 Bushing     | 24 Washer             |                  |

Figure 208. Steering axle (rear) wheel brake assembly, exploded view.

ing springs in the hydraulic control valve, the spool in the valve moves to direct the flow from the hydraulic pump to the hydraulic steering cylinder on the steering axle. This helps to turn the rear wheels in the desired direction. The valve spool moves axially in the valve body; when the valve is in the center position, the oil pressure produces ineffective forces in the steering cylinder. However, oil continues to circulate with only sufficient pressure to overcome the friction of lines and fittings.

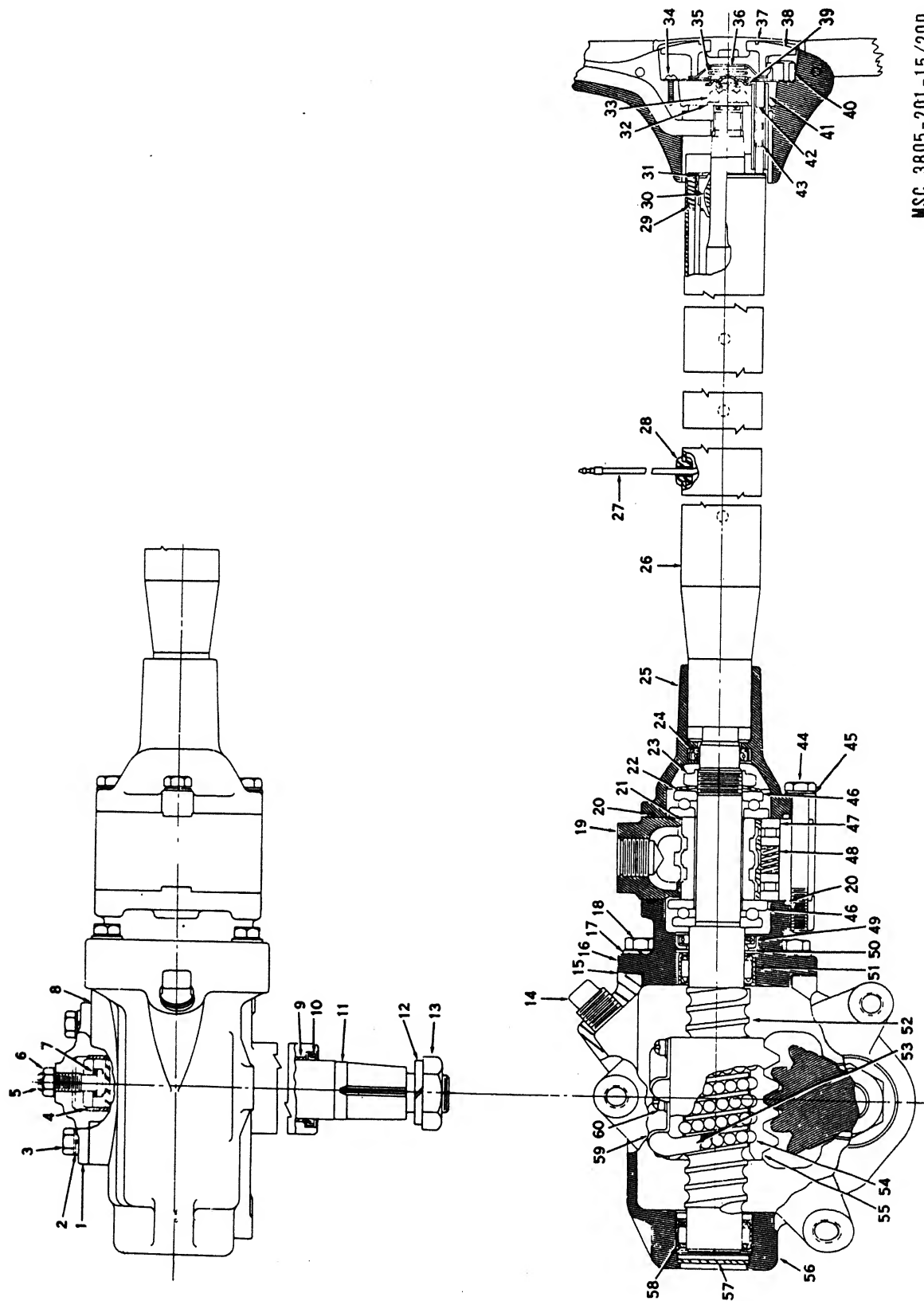
*b. Removal and Disassembly.*

- (1) Remove the control levers from the

steering column as directed in paragraph 172b.

- (2) Remove the handbrake valve and mounting parts from the steering column as directed in paragraph 189a. Remove the two nuts and lockwashers that secure the U-bolt to the steering gear bracket; remove the U-bolt and block.
- (3) Disconnect the horn cable (27, fig. 209) at the lower end of the steering column from the power supply lead.
- (4) Disconnect the hoses (6, 7, 9, 10, and

- 13, fig. 88) from the steering gear. Cover or plug the exposed hoses and ports to keep dirt out of the hydraulic system.
- (5) Remove the drag link from the steering gear as directed in paragraph 200b.
  - (6) Remove the capscrew (8, fig. 89) and lockwasher that secure the cable clamp (7) to the steering gear. Remove the three capscrews (6) and lockwashers that secure the steering gear (5) to the support; remove the steering gear assembly from the loader and place it on a bench.
  - (7) Remove the nut (13, fig. 209) and lockwasher (12) that secure the pitman arm (2, fig. 90); remove the pitman arm.
  - (8) Pry out and twist slightly to remove the assembled horn button cover (37, fig. 209) and horn button (38) from the steering wheel. If damaged, remove the cover from the button.
  - (9) Remove the contact cap, spring (35), and contact cup (39) from the recess in the steering wheel.
  - (10) Remove the three screws (34) that secure the base plate (40) to the steering wheel; remove the base plate.
  - (11) Remove the sleeve (41); remove the two brushes (42) and spring (43) from the sleeve.
  - (12) Remove the nut (33) and lockwasher (32) that secure the steering wheel to the steering shaft; remove the wheel.
  - (13) Thoroughly clean the exterior of the steering gear prior to disassembly. Scribe a mark on the steering gear housing (56), valve-to-housing adapter (16), valve housing (19), and valve cover (25) to insure proper positioning of parts during reassembly.
  - (14) Remove the three bolts (44) and lockwashers (45) that secure the valve cover (25) to the valve housing (19) and the valve housing to the adapter; remove the valve cover and jacket (26) from the worm and steering shaft (52).
  - (15) Remove the insert (30) from the jacket or steering shaft; lift the contact plate (31) just enough to separate the tang on the horn cable assembly (27) from the tang on the contact plate. Remove the seal (29) and contact plate (31) from the jacket. Remove the horn cable assembly by pulling it through the grommet (28) at the lower end of the jacket; remove the grommet from the jacket.
  - (16) Remove the seal (24) from the valve cover (25); remove the preformed packing (20) from the valve cover.
  - (17) Cut out the staked area that locks the worm bearing nut (23) to the shaft; be careful to avoid damage to the threads on the shaft. Remove and discard the worm bearing nut.
  - (18) Remove the valve preload spring (22) and thrust bearing (46) from the shaft; keep the two races and the ball bearing together.
  - (19) Remove the assembled valve housing (19) and valve spool (21), being careful not to lose the centering plungers (47) and centering springs (48); remove the six plungers, three springs, and valve spool from the valve housing. Note the position of the spool in the body before disassembly. Place the parts on a clean piece of paper to protect them from foreign material.
  - (20) Remove the thrust bearing (46) from the adapter side of the shaft; keep the two races and the ball bearing together.
  - (21) Remove the four bolts (18) and lockwashers (17) that secure the adapter (16) to the steering gear housing; remove the adapter from the shaft.
  - (22) Remove the remaining preformed packing (20), worm seal (49), and washer (50) from the adapter. If the needle bearing (51) is damaged and must be removed, press it from the adapter. Remove the gasket (15) from the adapter.
  - (23) Remove the filler plug (14) from the steering gear housing.
  - (24) Secure the housing in a vise. Remove the bolts (3) and lockwashers (2) that secure the housing side cover (1) to the housing; remove the assembled cover and pitman shaft gear (11).



MSC 3805-201-15/209

Figure 209. Steering gear assembly, cross-sectional view



1	Housing side cover	17	Lockwasher	33	Nut	48	Valve centering spring
2	Lockwasher	18	Bolt	34	Screw	49	Worm seal
3	Bolt	19	Valve housing	35	Spring	50	Washer
4	Pitman shaft Bushing	20	Preformed packing	36	Contact cup	51	Needle bearing
5	Lash adjuster screw	21	Valve spool	37	Horn button cover	52	Worm and steering shaft
6	Lash adjuster nut	22	Valve preload spring	38	Horn button	53	Ball return guide
7	Shim	23	Worm bearing nut	39	Contact cup	54	Ball
8	Gasket	24	Valve cover seal	40	Base plate	55	Ball nut
9	Pitman shaft bushing	25	Valve cover	41	Sleeve	56	Steering gear housing
10	Seal	26	Steering column jacket	42	Brush	57	Expansion plug
11	Pitman shaft gear	27	Horn cable assembly	43	Spring	58	Needle bearing
12	Lockwasher	28	Grommet	44	Bolt	59	Ball return guide clamp
13	Nut	29	Seal	45	Lockwasher	60	Bolt
14	Filler plug	30	Insert	46	Thrust bearing		
15	Adapter gasket	31	Contact plate	47	Valve centering plunger		
16	Valve-to-housing adapter	32	Lockwasher				

Figure 209—Continued.

- (25) Remove the lash adjuster nut (6) that secures the lash adjuster screw (5) to the housing side cover; screw the lash adjuster screw out of the cover.
  - (26) Slide the lash adjuster screw out of the pitman shaft gear; remove the shim or shims (7) from the lash adjuster screw. Remove the gasket (8). Remove the seal (10) from the steering gear housing.
  - (27) Remove the assembled ball nut (55) and shaft (52) from the steering gear housing.
  - (28) Remove the three bolts (60) that secure the ball return guide clamp (59) to the ball nut; remove the clamp, four ball return guides (53), and 106 balls (54) from the ball nut. Remove the ball nut from the worm and steering shaft.
  - (29) If the pitman shaft bushings (4 and 9) are damaged and must be removed, use a press to force the bushings from their positions.
  - (30) If the needle bearing (58) is damaged and must be removed, press it from the steering gear housing. If the expansion plug (57) must be removed, drive it out from the outside of the steering gear housing.
- c. Cleaning and Inspection.*
- (1) Clean all metal parts with an approved cleaning solvent; clean the machined parts individually to avoid damage to the surfaces. Dry all parts except the bearings with clean, dry compressed air. Wipe the bearings with a clean, lint-free cloth.
  - (2) Wipe all grease and dirt from the non-metallic parts with a clean, dry cloth.
  - (3) Inspect the worm and steering shaft (52) and pitman shaft gear (11) for excessive wear, cracks, and distortion, and damaged splines and threads; replace if damaged.
  - (4) Inspect the housing side cover (1) and steering gear housing (56) for cracks and damaged threads.
  - (5) Inspect the valve housing (19) and valve spool (21) for nicks, scoring, cracks, and other damage. These parts are selectively fitted and are not separately replaceable; replace both parts if either is damaged.
  - (6) Inspect the valve centering springs (48) for cracks, distortion, and loss of compression. Inspect the valve preload spring (22) for distortion and loss of compression.
  - (7) Inspect the valve centering plungers (47) for nicks or scratches.
  - (8) Inspect the thrust bearings (46) and needle bearings (58 and 51) for excessive wear, rough or catchy operation, binding, sticking, or other damage.
  - (9) Inspect the pitman shaft bushings (4 and 9) for nicks, scratches, excessive wear, and other damage.
  - (10) Inspect the ball nut (55) for scoring, excessive wear, and damage. Inspect the ball return guides (53) and the balls (54) for nicks, distortion, excessive wear, and damage.
  - (11) Inspect the valve-to-housing adapter (16) and valve cover (25) for cracks, excessive wear of bearing and seal bores, and damage.

- (12) Inspect the horn cable assembly (27) for cracked insulation and damage; make sure that the terminal tank is secure.
- (13) Inspect the contact plate (31) for scoring and excessive wear.
- (14) Inspect the grommet (28), seal (29), and insert (30) for excessive wear and deterioration.
- (15) Replace all gaskets, preformed packings, oil seals, and damaged or defective parts.

*d. Reassembly and Installation.*

- (1) If removed, press the expansion plug (57) into position in the steering gear housing (56).
- (2) If removed, install the needle bearing (58) into the steering gear housing with the trademark outward. Press the bearing into place until it is just below the chamfer in the bore.

*Note.* Do not press the needle bearing in so far that it bottoms on the shoulder in the casting below the bearing.

- (3) If removed, press the pitman shaft bushings (4 and 9) into their respective positions.
- (4) Slide the lash adjuster screw (5) into the slot of the pitman shaft gear (11); place the proper shim (7) on the lash adjuster screw to obtain a 0.002-inch clearance in the slot.
- (5) Use a screwdriver to thread the lash adjuster screw into the housing side cover (1); the adjuster screw acts as a screw jack to pull the pitman shaft gear (11) into the side cover. Secure the lash adjuster screw with a nut (6).
- (6) Thoroughly coat the steering gear housing seal (10) with an approved lubricant and press the seal into place in the steering gear housing. Take care not to damage the seal lip.
- (7) Center the ball nut (55) on the worm and steering shaft (52). Install the balls (54) in the ball nut by pushing them into one hole until they surface at the return hole (53 balls are required in each of the two circuits). When the balls have filled each circuit, install the ball return guides (53) and the remainder of the balls.

*Note.* Light grease placed in the ball re-

turn guides will hold the balls to facilitate reassembly.

- (8) Position the ball return guide clamp (59) on the ball nut; secure with bolts (60). If the ball nut (55) is centered correctly, the ball race grooves on the worm on each side of the ball nut are equal.
  - (9) Insert the bottom of the steering shaft into the needle bearing (58) at the bottom of the steering gear housing.
  - (10) Position the side cover gasket (8) on the steering gear housing; align the center tooth of the pitman shaft gear with the center slot of the ball nut rack gear. Slide the pitman shaft gear into the steering gear housing; secure the housing side cover (1) to the steering gear housing with the three bolts (3) and lockwashers (2). Tighten the bolts to a torque of 25 to 30 foot-pounds. Check the steering gear lash as directed in paragraph 199a(3).
  - (11) Adjust the lash between the two gears as directed in paragraph 199a.
  - (12) Install the needle bearing (51) into the adapter (16) with the trademark side outward. Press the bearing into place until the outside face is just below the surface of the adapter.
- Note.* Do not press the bearing in so far that the bottom of the bearing contacts the shoulder of the casting.
- (13) Position the washer (50) into position in the adapter (16). Thoroughly coat the worm seal (49) with an approved lubricant and press the seal into the adapter. Take care not to damage the seal lip.
  - (14) Position the adapter gasket (15) on the steering gear housing; carefully slide the assembled adapter over the steering shaft into position against the steering gear housing. Secure the adapter to the steering gear housing with the four bolts (18) and lockwashers (17). Tighten the bolts to a torque of 17 to 23 foot-pounds.
  - (15) Coat the valve centering plungers (47) and valve spool (21) with an approved lubricant. Install the valve spool in the valve housing (19) in the same position as was noted upon re-

- movel. Do not force the spool into the valve housing; forcing will damage the spool and the valve bore.
- (16) Install a valve centering plunger (47) at each end of the three bores; install a valve centering spring (48) and a valve centering plunger into the opposite end of the three bores.
  - (17) Install a preformed packing (20) in the groove of the adapter face.
  - (18) Position the small race of the thrust bearing (46) on the bench with the groove up. Position the ball bearing in the groove; then position the large race groove down, on top of the bearing. Keep these parts together as an assembly; hold them firmly and place against the bottom of the valve assembly, the large race in contact with the valve housing. Carefully lower this assembly into position on the adapter. Make sure that the scribe marks made during disassembly line up properly.
  - (19) Install the large race (groove up), ball bearing, and small race (groove down) of the remaining thrust bearing into position on the valve housing.
  - (20) Install the valve preload spring (22), convex side up, on the small race of the thrust bearing.
  - (21) Install the worm bearing nut (23) on the threaded portion of the worm and steering shaft (52). To prevent the worm and steering shaft (52) from turning when tightening the nut (23), install the steering wheel and secure with the nut (33) and lockwasher (32). While someone grips the steering wheel to keep the steering shaft steady, tighten the worm bearing nut to a torque of 20 to 30 foot-pounds. Back the nut off about a quarter-turn and stake the nut to the groove in the steering shaft as shown in figure 210; be sure to support the shaft from the opposite side of the groove to prevent shaft damage while staking. Remove the steering wheel and washer.
  - (22) Thoroughly coat the valve cover seal (24, fig. 209) and cover (25) with an approved lubricant; take care not to damage the seal lip.
  - (23) Install the preformed packing (20) into position in the face of the valve cover.
  - (24) Install the valve cover and jacket (26) over the worm and steering shaft; be very careful to prevent damage to the seal (24). Make sure that the scribe marks made during disassembly line up properly.
  - (25) Secure the valve cover to the adapter with the three bolts (44) and lockwashers (45). Tighten the bolts to a torque of 17 to 23 foot-pounds.
  - (26) Fill the steering gear housing with lubricant as specified in the lubrication order (fig. 27). Install the filler plug (14, fig. 209).
  - (27) Install the grommet (28) into position at the lower end of the steering column jacket (26). Insert the tang end of the horn cable assembly (27) through the grommet and pull it to the top of the well in the jacket. Install the insert (30) into position on the worm and steering shaft. Thread the tang of the cable assembly through the seal (29); lock the tang of the cable assembly to the hole of the tang in the contact plate (31). Press the contact plate into the seal; then press this assembly into position between the worm and steering shaft and the jacket. Make sure that the entire assembly is securely positioned around the insert.
  - (28) Install the pitman arm (2, fig. 90) on the shaft of the shaft and gear; secure with a nut (13, fig. 209) and lockwasher (12).
  - (29) Position the steering wheel on the steering shaft; secure with a nut (33) and lockwasher (32).
  - (30) Install a brush (42), the spring (43), and another brush in the sleeve (41); hold the assembly together and install the sleeve in the steering wheel recess.
  - (31) Position the base plate (40) in the recess, over the sleeve; secure to the steering wheel with the three screws (34).
  - (32) Install the contact cap (39), spring (35), and contact cup (36) in the center hole of the base plate with the con-

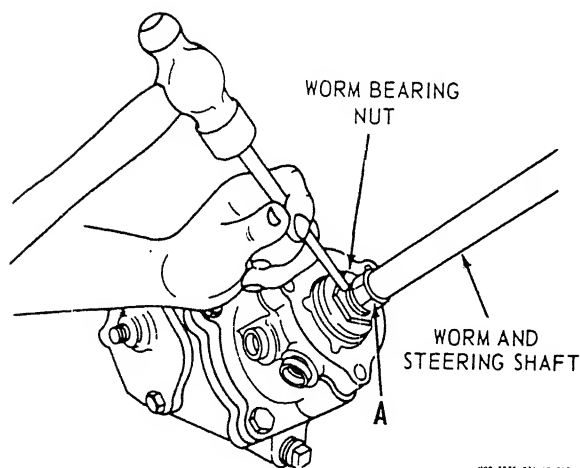


Figure 210. Staking worm bearing nut.

tact cap covering the nut of the steering wheel and the contact cup facing downward.

- (33) If the cover (37) of the horn button (38) was removed, force it into position on the horn button. Install the assembled horn button and cover over the steering wheel recess; twist to engage the base plate.
- (34) Install the steering gear assembly into the loader; secure to the main frame with the three capscrews and lockwashers.
- (35) Install the drag link on the steering gear as directed in paragraph 200d.
- (36) Connect the hoses (6, 7, 9, 10, and 13, fig. 88) to the steering valve. Fill the hydraulic system as directed in paragraph 204c.
- (37) Install the U-bolt and block that secure the upper steering gear; secure with the two nuts and lockwashers. Connect the horn cable assembly (27, fig. 209) at the lower end of the steering column to the power supply lead.
- (38) Install the handbrake valve and mounting parts on the steering column as directed in paragraph 190c.
- (39) Install the control levers on the steering column as directed in paragraph 172d.

## 264. Steering Axle

a. *General.* The steering axle is mounted at the rear of the loader and is driven by the transmission through the lower rear drive shaft. The gear reduction and drive action are

the same as for the rigid axle (par. 265) except that a universal joint assembly is located in the steering knuckle at each axle hub to accommodate the steering motion. Provision is made on the steering knuckles for attaching the tie rod, steering cylinders, and steering linkage.

### b. Removal.

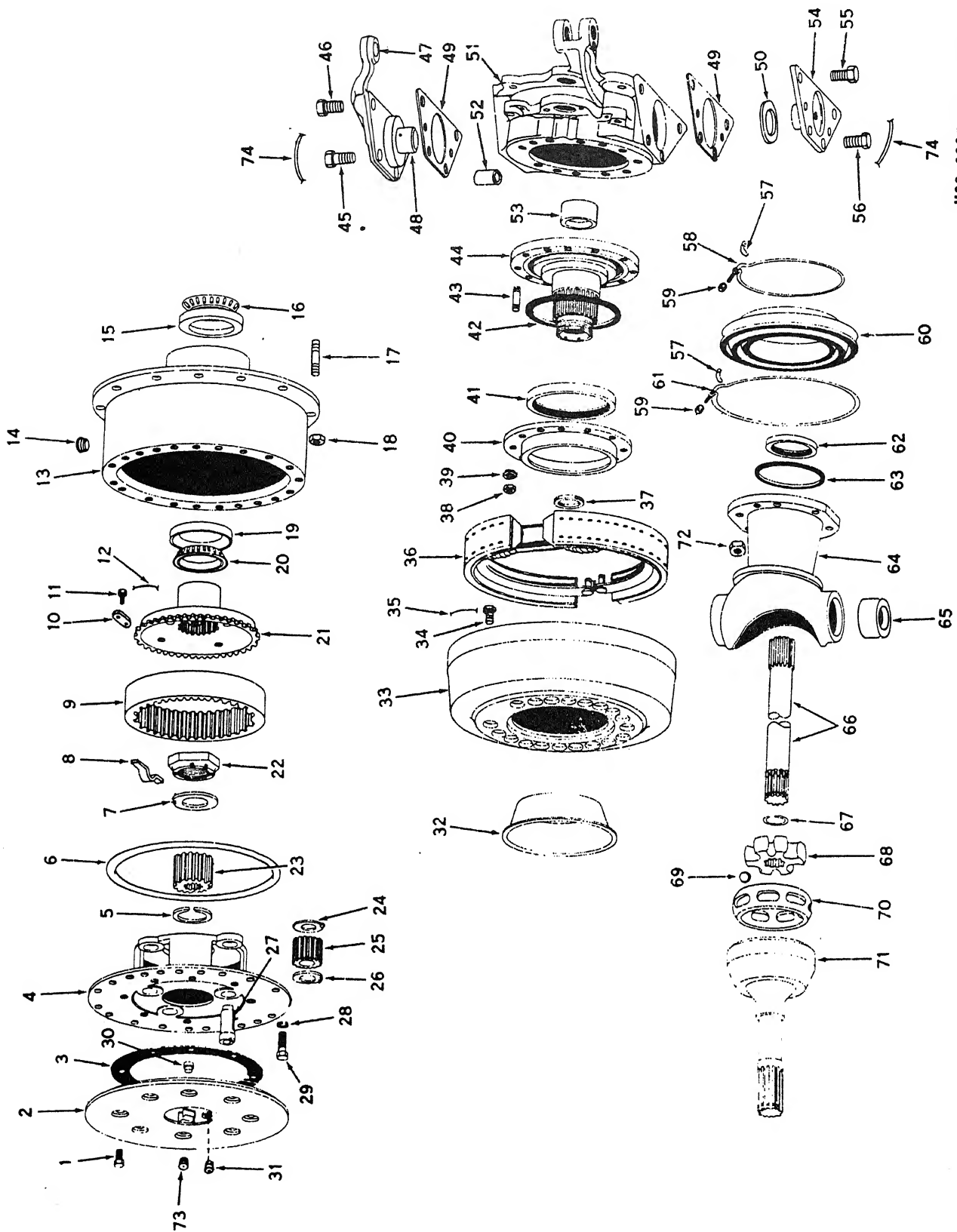
- (1) Block the front wheels securely to prevent movement of the loader.
- (2) Raise the bucket approximately 1 foot off the ground and tilt it back; raise the rear end of the loader with suitable jacks until the wheels are 2 inches off the ground.
- (3) Place blocking under the frame at the rear of the loader to support it with the wheels off the ground.
- (4) Remove the wheels and tires from the wheel hubs as directed in paragraph 177a.
- (5) Provide suitable containers to catch the gear oil. Remove the axle housing plugs and the drain plug (14, fig. 211) at each of the wheel hubs. After allowing the lubricant to thoroughly drain, reinstall the plugs to prevent the entrance of dirt or foreign matter into the wheel hubs and differential.
- (6) Disconnect the lower rear drive shaft from the steering axle as directed in paragraph 217a.  
*Note.* Either the final drive or the differential can be disassembled without completely removing the steering axle from the loader.
- (7) Disconnect the hoses (29 and 32, fig. 83) from the wheel cylinders.
- (8) Tag and disconnect the hoses (1, 15, 16, and 17, fig. 88) from the steering cylinders; plug the openings to prevent the entrance of dirt into the hydraulic system.
- (9) Disconnect the drag link from the steering arm as directed in paragraph 200b(3).
- (10) Support the steering axle with a cradle or jacks; remove the eight self-locking nuts (15, fig. 217) and capscrews (16) that secure each side of the axle housing to the cradle (17). Move the steering axle to a suitable work area for disassembly.
- (11) Thoroughly clean all grease and dirt from the exterior of the steering axle

prior to disassembly by steam-cleaning or brushing with an approved cleaning solvent.

*c. Disassembly (fig. 211).*

(1) Disassemble each of the two steering axle final drives as follows:

- (a) Remove the eight screws (1) that secure the cover (2) to the planetary spider; remove the cover and gasket (3).
  - (b) Remove the plugs (31 and 73) from the cover. If the thrust button (30) is worn or damaged, remove it from the cover.
  - (c) Remove the 16 screws (29) and lockwashers (28) that secure the planetary spider (4) to the wheel hub (13). Install the puller screws in the three holes provided and tighten evenly; remove the planetary spider and preformed packing (6).
  - (d) Press the three pinion shafts (27) from the planetary spider; remove the three spur gears (25), inner thrust washers (24), and outer thrust washers (26).
  - (e) Remove the retaining ring (5) from the outer race; remove the spur gear (23) and thrust washer (7).
  - (f) Remove the two locks (8) and nut (22) that secure the assembled internal gear and hub to the spindle (44); remove the assembled internal gear and hub. Use the puller screws in the holes provided to start the hub off of the splines.
  - (g) Remove the hub outer bearing cone (20) from the assembled internal gear and hub.
  - (h) Remove the lockwire (12), eight screws (11), and four locks (10) that secure the internal gear (9) to the hub (21); remove the internal gear.
  - (i) Remove the assembled wheel hub and brake drum from the spindle.
  - (j) Remove the lockwire (35) and 19 screws (34) that secure the brake drum (33) to the wheel hub (13); remove the drum and oil slinger (32).
  - (k) Remove the outer bearing cup (19) and inner bearing cup (15) from the wheel hub. Remove any of the wheel studs (17) that are loose, stripped, or damaged.
- (2) Disassemble the wheel brake assembly (36) as directed in paragraph 261a.
  - (3) Remove the 12 nuts (38) and lockwashers (39) that secure the spindle assembly to the steering knuckle; remove the assembled seal and retainer and the preformed packing (42).
  - (4) Remove the seal (41) from the seal retainer (40).
  - (5) Remove the hub inner bearing cone (16) and the seal (37) from the spindle assembly.
  - (6) If damaged or excessively worn, remove the bushing (53) from the spindle.
  - (7) Remove the universal joint cage assembly from the steering knuckle and disassemble as follows:
    - (a) Clamp the axle shaft (66) in a soft-jawed vise, with the outer race (71) downward.
    - (b) Drive the assembled outer race, bearings, and cage from the axle shaft by using a bronze drift against the end of the inner race (68).
    - (c) Remove the retaining ring (67) from the axle shaft and discard.
    - (d) Tilt the inner race and cage (70) in the outer race until one of the bearing balls (69) can be lifted out; continue in this manner until the six bearing balls are removed.
    - (e) Roll the cage and inner race at right angles to the outer race with the two elongated openings in the cage aligned with the opposite teeth of the outer race; remove the cage and inner race.
    - (f) Turn the inner race at right angles to the cage; align the tooth of the inner race with the elongated hole in the cage and roll the inner race from the cage.
  - (8) Remove the cotter pin, nut, and bolt that secure each end of the tie rod to the steering knuckles; remove the



MSC 3805-201-15/211

Figure 211. Steering axle, exploded view.

1	Screw	20	Bearing cone	39	Lockwasher	57	Clamp sleeve
2	Cover	21	Internal gear hub	40	Retainer	58	Inner boot clamp
3	Gasket	22	Nut	41	Seal	59	Nut
4	Planetary spider	23	Spur gear	42	Preformed packing	60	Boot
5	Retaining ring	24	Inner thrust washer	43	Stud	61	Outer boot clamp
6	Preformed packing	25	Spur gear	44	Spindle	62	Seal
7	Thrust washer	26	Outer thrust washer	45	Screw	63	Preformed packing
8	Lock	27	Pinion shaft	46	Screw	64	Trunnion socket
9	Internal gear	28	Lockwasher	47	Steering arm	65	Bushing
10	Lock	29	Screw	48	Bearing sleeve	66	Axle shaft
11	Screw	30	Thrust button	49	Shim	67	Retaining ring
12	Lockwire	31	Plug	50	Thrust washer	68	Inner race
13	Wheel hub	32	Oil slinger	51	Steering knuckle	69	Bearing ball
14	Plug	33	Brake drum	52	Bushing	70	Cage
15	Inner bearing cup	34	Screw	53	Bushing	71	Outer race
16	Bearing cone	35	Lockwire	54	Lower cap	72	Nut
17	Stud	36	Brake assembly	55	Screw	73	Plug
18	Nut	37	Seal	56	Screw	74	Lockwire
19	Outer bearing cup	38	Nut				

Figure 211—Continued.

- assembled tie rod and yokes. Remove the lubrication fitting from the bolts.
- (9) Remove the two bolts, nuts, and lockwashers that secure each of the yokes to the tie rod; remove the yokes and the nut.
  - (10) Remove the steering cylinders as directed in paragraph 201a.
  - (11) Remove the nut (59), outer boot clamp (61), and clamp sleeve (57) from the steering knuckle; slide the boot from the lip of the steering knuckle.
  - (12) Disassemble the left steering knuckle as follows:
    - (a) Remove the lockwire and four screws (45 and 46) that secure the steering arm (47) to the steering knuckle (51); remove the steering arm and shims (49).
    - (b) If excessively worn or damaged, remove the bearing sleeve (48) from the steering arm.
    - (c) Remove the lockwire (74) and four screws (55 and 56) that secure the lower cap (54) to the steering knuckle; remove the lower cap, shims (49), and thrust washer (50).
  - (13) Disassemble the right steering knuckle as follows:
    - (a) Remove the lockwire (74) and four screws (45 and 46) that secure the upper cap to the steering knuckle; remove the cap and shims.
    - (b) Remove the lockwire and four screws that secure the lower cap to the steering knuckle; remove the lower cap, shims, and thrust washer (50).
  - (14) Index-mark the trunnion sockets to the axle housing. Remove the eight nuts that secure the trunnion socket (64) to the axle housing; remove the trunnion socket and preformed packing.
  - (15) Remove the nut (59), inner boot clamp (58), and clamp sleeve (57) that secure the boot (60) to the trunnion socket; remove the boot. Remove the seal (62) from the trunnion socket.
  - (16) If the bushings (65) are excessively worn or damaged, press them from the trunnion socket.
  - (17) Provide a suitable support for the differential. Remove the 14 nuts and lockwashers that secure the differential to the axle housing; remove the differential and the gasket. Overhaul the differential as directed in paragraph 266.
  - (18) Remove the breather and plugs from the axle housing.
  - (19) If any of the studs are stripped or damaged, remove them from the axle housing.
- d. *Cleaning and Inspection.*
- (1) Thoroughly clean all metallic parts by washing with an approved solvent; dry with clean, dry compressed air. Lightly coat all bearings with clean lubricating oil.
  - (2) Inspect the roller bearings for cracks, nicks, excessive looseness, or rough or binding operation. Inspect the bearing cups for scoring, pitting, or excess-



sive wear. If any of the bearing cups or bearing cones are defective, replace both mating parts.

- (3) Inspect the gears and shafts for cracks, chipped or excessively worn gear teeth or splines, and scored or excessively worn bearing surfaces.
  - (4) Inspect the steering knuckle and wheel hub for cracks, loose or damaged studs, stripped threads, or other damage.
  - (5) Inspect the parts of the universal joint cage assembly for cracks, scoring, excessive wear, or other damage.
  - (6) Inspect the steering arm, upper cap, and lower caps for cracks, excessive wear, or damage.
  - (7) Inspect the axle housing for cracks, stripped threads, and other damage.
  - (8) Inspect the spindle for cracks, stripped threads, damaged splines, or excessively worn or damaged bushing.
  - (9) Inspect the boot for cracks or deterioration.
  - (10) Inspect and, if necessary, repair the brake drum as directed in paragraph 261b(4).
  - (11) Replace all seals, preformed packings, lockwire, retaining rings, cotter pins, gaskets, and other unserviceable parts.
- e. *Reassembly* (fig. 211).
- (1) Install new studs on the axle housing to replace any studs that were removed.
  - (2) Install the breather and plugs on the axle housing.
  - (3) Position the gasket and the assembled differential on the axle housing; secure with the 14 nuts and lockwashers. Tighten the nuts to a torque of 168 to 180 foot-pounds.
  - (4) If the bushings (65) were removed, install new bushings in the trunnion socket (64). Install the seal (62) in the trunnion socket so that the lip of the seal is outward.
  - (5) Position the boot (60) on the trunnion socket. Install the inner boot clamp (58) with the clamp sleeve (57) at the connection; secure with the nut (59).
  - (6) Position the preformed packing (63) in the groove of the trunnion socket. Align the index marks and position the

trunnion socket on the axle housing; secure with the eight nuts and lockwashers.

- (7) Install new studs (43) on the steering knuckles to replace any that are missing or damaged. Reassemble the right steering knuckle as follows:
  - (a) Position the steering knuckle over the trunnion socket. Position the lower cap, thrust washer, and shims; secure with the four screws.
  - (b) Position the shims and upper cap on the steering knuckle; secure with the four screws.
  - (c) Tighten the eight screws to a torque of 515 to 570 foot-pounds. Check the steering knuckle for end play and free rotation; if there is end play, remove the shims to obtain zero end play. If there is binding, add the shims to obtain free rotation with zero end play. Divide the shims equally between the upper and lower cap.
  - (d) Retighten the screws to a torque of 515 to 570 foot-pounds; lock with the lockwire.
- (8) Reassemble the left steering knuckle as follows:
  - (a) Position the steering knuckle over the trunnion socket. Position the lower cap (54), thrust washer (50), and shims (49) on the steering knuckle; secure with the four screws (55 and 56).
  - (b) If the bearing sleeve (48) was removed, install a new bearing sleeve on the steering arm (47), taking care to align the hole in the bearing sleeve with the lubrication hole in the steering arm.
  - (c) Position the shims (49) and steering arm on the steering knuckle; secure with the four screws (45 and 46).
  - (d) Check for end play and free rotation; tighten the screws as directed in subparagraphs (7)(c) and (d) above; install the lockwire (74).
- (9) Position the boot over the steering knuckle; secure with the outer boot clamp, clamp sleeve, and nut.

- (10) Install the nut and yokes on the tie rod; secure each of the yokes with the two screws, nuts, and lockwashers.
- (11) Position the assembled tie rod and yokes on the steering knuckles; secure each end of the tie rod with a bolt, nut, and cotter pin.
- (12) Install the steering cylinders as directed in paragraph 201c.
- (13) Reassemble the universal joint cage assemble as follows:
  - (a) Position the inner race (68) at right angles to the cage (70) and aline with the elongated cage hole; turn the inner race into the cage and aline parallel.
  - (b) Aline the two elongated openings of the cage at right angles to the teeth of the outer race (71); insert the inner race and cage into the outer race.
  - (c) Tilt the inner race and cage and install each of the six bearing balls (69) into the outer race.
  - (d) Position the outer race in a soft-jawed vise; aline the inner race parallel with the face of the outer race.
  - (e) Install the retaining ring (67) in the groove of the axle shaft (66).
  - (f) Aline the splines of the axle shaft and inner race; tap the end of the axle shaft with a rawhide mallet to collapse the retaining ring. Drive the axle shaft through the inner race until the retaining ring clears the splines and opens.
- (14) Install the universal joint cage assembly into the steering knuckle, taking care not to damage the seal; turn as required to obtain alinement of the axle shaft with the differential gear splines.
- (15) Install the bushing (53); seal (37), with the lip of the seal outward; and the bearing cone (16) on the spindle (44).
- (16) Install the seal (41) in the seal retainer (40).
- (17) Position the assembled spindle, preformed packing (42), and the assembled seal retainer and seal on the steering knuckle; secure with the 12

- nuts (38) and lockwashers (39).
- (18) Reassemble the wheel brake as directed in paragraph 261c.
- (19) Reassemble each of the two steering axle final drives as follows:
  - (a) Install new studs (17) on the wheel hub (13) to replace any that were removed. Press the bearing cups (15 and 19) into their respective positions on the wheel hub.
  - (b) Position the oil slinger (32) and the brake drum (33) on the wheel hub; secure with 19 screws (34). Tighten the screws to a torque of 168 to 180 foot-pounds; lock with the lockwire (35).
  - (c) Position the assembled wheel hub and brake drum over the spindle, taking care not to damage the seal or the bearings.
  - (d) Position the internal gear (9) on the hub (21); secure with the four locks (10) and eight screws (11). Tighten the screws to a torque of 34 to 37 foot-pounds; lock with the lockwire (12).
  - (e) Install the bearing cone (20) on the assembled internal gear and hub.
  - (f) Install the assembled internal gear and hub on the splines of the spindle; secure with the nut (22). Tighten the nut to a rolling torque of 6 to 10 foot-pounds. This is accomplished by tightening the nut and wrapping a wire around the hub five or six times. With a pull scale attached to the wire, measure the torque while the hub is rolling. Tighten to make the lock fit. Do not loosen the nut to fit the lock.
  - (g) Position the thrust washer (7) and spur gear (23) on the splines of the outer race (71); secure with the retaining ring (5).
  - (h) Position an inner thrust washer (24) (with smaller diameter hole) on the planetary spider (4) so the tab faces away from the spur gear and engages the slot of the planetary spider.
  - (i) Position a spur gear (25) and outer thrust washer (26) on the planetary spider so that the holes are

- alined; press the pinion shaft (27) (small diameter first and the machined flat facing toward the outside diameter of the planetary spider) through the planetary spider and spur gear until the shoulder butts against the inner thrust washer.
- (j) Assemble the remaining thrust washers and spur gear into the planetary spider in the same manner.
  - (k) Position the preformed packing (6) and the assembled planetary spider and spur gears on the wheel hub; secure with the 16 screws (29) and lockwashers (28).
  - (l) Install the thrust button (30) on the cover (2).
  - (m) Aline the **FILL** arrow of the cover with the fill hole of the wheel hub. Position the gasket (3) and cover (2) on the planetary spider; secure with the eight screws (1). Tighten the screws to a torque of 54 to 58 foot-pounds.
  - (n) Install the plugs (31 and 73) on the cover and the plug (14) on the wheel hub.

*f. Installation.*

- (1) Support the steering axle with a cradle or jacks against the axle swivel. Position the anchor brackets beneath the mounting pads of the axle housing; secure the anchor brackets and steering axle to the axle swivel with 8 bolts and 16 nuts, with the inside bolts installed from the bottom and the outside bolts installed from the top.
- (2) Connect the drag link to the steering arm as directed in paragraph 200d.
- (3) Connect the hoses (1, 15, 16, and 17, fig. 88) to their respective steering cylinders.
- (4) Connect the hoses (29 and 32, fig. 83) to the hydraulic brake cylinders.
- (5) Connect the lower rear drive shaft to the steering axle as directed in paragraph 217e.
- (6) Install the wheels and tires as directed in paragraph 177c.
- (7) Lubricate the steering axle final drives and differential as directed in the lubrication order (fig. 27).

- (8) Check the level of the hydraulic oil reservoir as directed in paragraph 204a.
- (9) Bleed the hydraulic brake system as directed in paragraph 186b.
- (10) Remove all blocking from beneath the loader frame and wheels.

## 265. Rigid Axle

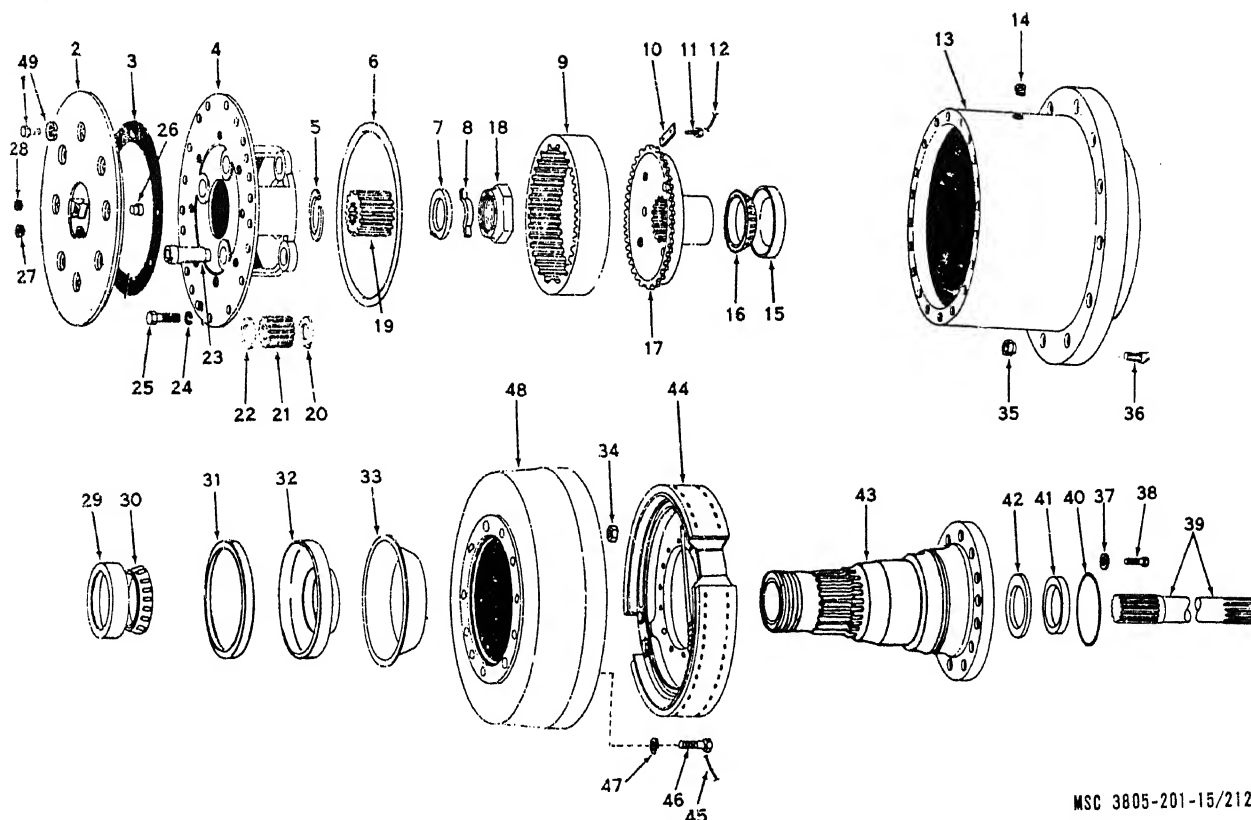
*a. General.* The rigid axle, mounted at the front of the loader, is driven through the transmission and the front drive shaft. The pinion and ring gear drive the differential spider to provide a 5-2/7 to 1 gear reduction and differential action for the front axles. Each axle hub contains a planetary final drive to provide a further gear reduction of 3.6 to 1 to the wheels.

*b. Removal.*

- (1) Block the rear wheels securely to prevent movement of the loader.
- (2) Raise the front end of the loader until the front wheels are 2 inches off the ground, and place the blocking under the frame at the front of the loader.
- (3) Remove the wheels and tires from the hubs as directed in paragraph 177a.
- (4) Provide suitable containers to catch the gear oil. Remove the plug from the axle housing and the plug (14, fig. 212) from each of the wheel hubs. After allowing the lubricant to thoroughly drain, reinstall the plugs to prevent dirt from entering the wheel hubs and differential.
- (5) Disconnect the lower front drive shaft from the rigid axle as directed in paragraph 217a.

*Note.* Either the final drive or the differential can be disassembled without completely removing the rigid axle from the loader.

- (6) Disconnect the hydraulic brake lines from the wheel cylinders.
- (7) Support the rigid axle with a mobile jack or on a dolly so it can be removed to a suitable area for disassembly. Remove the eight nuts (20, fig. 217) and capscrews (19) that secure the axle housing to the loader frame; remove the assembled rigid axle.
- (8) Thoroughly clean all grease and dirt from the exterior of the rigid axle be-



MSC 3805-201-15/212

1 Screw	14 Plug	26 Thrust button	38 Screw
2 Cover	15 Bearing cup	27 Plug	39 Axle shaft
3 Gasket	16 Bearing cone	28 Plug	40 Preformed packing
4 Planetary spider	17 Internal gear hub	29 Bearing cup	41 Seal
5 Retaining ring	18 Nut	30 Bearing cone	42 Retainer
6 Preformed packing	19 Spur gear	31 Seal	43 Spindle
7 Thrust washer	20 Inner thrust washer	32 Retainer	44 Brake assembly
8 Lock	21 Spur gear	33 Oil slinger	45 Lockwire
9 Internal gear	22 Outer thrust washer	34 Nut	46 Screw
10 Lock	23 Pinion shaft	35 Nut	47 Lockwasher
11 Screw	24 Lockwasher	36 Stud	48 Brake drum
12 Lockwire	25 Screw	37 Flat washer	49 Lockwasher

Figure 212. Rigid axle hub group, exploded view.

fore disassembly by steam-cleaning or by brushing with an approved cleaning solvent.

c. Disassembly (fig. 212).

(1) Disassemble each of the two rigid axle final drives as follows:

- Remove the eight screws (1) and lockwashers (49) that secure the cover (2) to the planetary spider; remove the cover and gasket (3).
- Remove the plugs (27 and 28) from the cover. If the thrust button (26) is worn or damaged, remove it from the cover.
- Remove the 16 screws (25) and lockwashers (24) that secure the plane-

tary spider to the wheel hub (13). Install the puller screws in the holes provided and tighten evenly; remove the planetary spider and preformed packing (6).

- Press each of the three pinion shafts (23) from the planetary spider; remove the three spur gears (21), inner thrust washers (20), and outer thrust washers (22).
- Remove the bearing cone (30) and the assembled seal retainer and seal from the spindle. Remove the seal (31) from the retainer (32).
- Remove the 14 screws (38), nuts (34), and flat washers (37) that secure the

brake assembly (44) and the spindle to the axle housing; remove the brake assembly, spindle (43), and preformed packing (40).

- (4) Overhaul the front brake assemblies as directed in paragraph 257.
- (5) Remove the retainer (42) and seal (41) from the axle housing.
- (6) Provide a suitable support for the differential. Remove the 14 nuts and lockwashers that secure the differential to the axle housing; remove the differential and gasket. Overhaul the differential as directed in paragraph 264.
- (7) Remove the breather and plugs from the axle housing.
- (8) If any of the studs are stripped, loose, or damaged, remove them from the axle housing.

*d. Cleaning and Inspection.*

- (1) Thoroughly clean all metal parts by washing with an approved solvent; dry with clean, dry compressed air. Lightly coat all bearings with clean lubricating oil.
- (2) Inspect the roller bearings for cracks, nicks, excessive looseness, or rough or binding operation. Inspect the bearing cups for scoring, pitting, or excessive wear. If any of the bearing cups or bearing cones are defective, replace both mating parts.
- (3) Inspect the gears and shafts for cracks, chipped or excessively worn gear teeth or splines, and scored or excessively worn bearing surfaces.
- (4) Inspect the spindle for cracks, stripped threads, or damaged splines.
- (5) Inspect the axle housing and planetary spider for cracks, stripped threads, or other damage.
- (6) Inspect and, if necessary, repair the brake drum as directed in paragraph 259c(4).
- (7) Replace all seals, preformed packings, lockwire, retaining rings, gaskets, and unserviceable parts.

*e. Reassembly (fig. 212).*

- (1) Install new studs on the axle housing to replace any studs that were removed.

- (2) Install the breather and plugs on the axle housing.
- (3) Install the seals (41, fig. 212) and seal retainers (42) on the axle housing.
- (4) Position the gasket and the assembled differential on the axle housing; secure with the 14 nuts and lockwashers. Tighten the nuts to a torque of 168 to 180 foot-pounds.
- (5) Position the preformed packing (40) in the groove of the spindle (43).
- (6) Position the spindle and the brake assembly (44), with the wheel cylinder at the top, on the axle housing; secure with the 14 screws (38), nuts (34), and flat washers (37). Tighten the screws to a torque of 186 to 205 foot-pounds.
- (7) Install the seal (31) in the seal retainer (32).
- (8) Position the assembled seal retainer and seal and the bearing cone (30) on the spindle.
- (9) Reassemble each of the rigid axle final drives as follows:
  - (a) Install new studs (36) on the wheel hub (13) to replace any studs that were removed. Press the bearing cups (15 and 29) into their respective positions on the wheel hub.
  - (b) Position the oil slinger (33) and the brake drum (48) on the wheel hub; secure with the 10 screws (46) and lockwashers (47). Tighten the screws to a torque of 168 to 180 foot-pounds; lock with the lockwire (45).
  - (c) Position the assembled wheel hub and brake drum over the spindle, taking care not to damage the seal or bearings.
  - (d) Position the internal gear (9) on the hub (17); secure with the four locks (10) and eight screws (11). Tighten the screws to a torque of 34 to 37 foot-pounds; lock with the lockwires (12).
  - (e) Install the hub outer bearing cone (16) on the hub.
  - (f) Position the assembled internal gear and hub on the splines of the spindle; secure with the nut (18). Tighten the nut to a rolling torque of 6

to 10 foot-pounds. This is accomplished by tightening the nut and wrapping a wire around the hub five or six times. With a pull scale attached to the wire, measure the torque while the hub is rolling. Tighten to make the lock fit. Do not loosen the nut to fit the lock.

- (g) Position the thrust washer (7) and spur gear (19) on the axle shaft (39); install the retaining ring (5).
- (h) Slide the assembled axle shaft and spur gear through the spindle and axle housing, taking care not to damage the seal; rotate the axle shaft slightly, if required, to obtain alinement with the differential gear.
- (i) Position an inner thrust washer (20) (the one with the smaller diameter hole) on the planetary spider (4) so the tab of the washer faces away from the spur gear and engages the slot of the planetary spider.
- (j) Position a spur gear (21) and outer thrust washer (22), with the tab of the washer alined with the slot of the planetary spider and all of the holes alined; press the pinion shaft (23), with the small diameter first and the machined flat facing the outside diameter of the planetary spider, through the planetary spider and spur gear until the shoulder butts against the inner thrust washer.
- (k) Assemble the remaining two spur gears, inner thrust washers, and outer thrust washers into the planetary spider as directed in (i) and (j) above.
- (l) Position the preformed packing (6) and the assembled planetary spider and spur gears on the wheel hub, alining the teeth of the spur gears with the spur gear on the axle shaft and the internal gear and the holes with the tapped holes of the wheel hub; secure with the 16 screws (25) and lockwashers (24). Tighten the screws to a torque of 85 to 91 foot-pounds.

- (m) Install the thrust button (26) on the cover (2).
- (n) Aline the FILL arrow of the cover with the fill hole of the wheel hub. Position the gasket (3) and the assembled cover and thrust button on the planetary spider; secure with the eight screws (1). Tighten the screws to a torque of 54 to 58 foot-pounds.
- (o) Install the plugs (27 and 28) on the cover and the plug (14) on the wheel hub.

*f. Installation.*

- (1) Support the assembled rigid axle against the loader frame; secure with the eight screws, installed from the bottom, and 16 nuts.
- (2) Connect the lower front drive shaft to the rigid axle differential as directed in paragraph 217.
- (3) Connect the hydraulic brake lines to the brake wheel cylinders.
- (4) Bleed all air from the hydraulic brake system as directed in paragraph 186b.
- (5) Install the wheels and tires as directed in paragraph 177c.
- (6) Adjust the front wheel brakes as directed in paragraph 186a.
- (7) Fill the axle housing and the final drives with the proper lubricants as directed in the lubrication order (fig. 27).

## 266. Differential

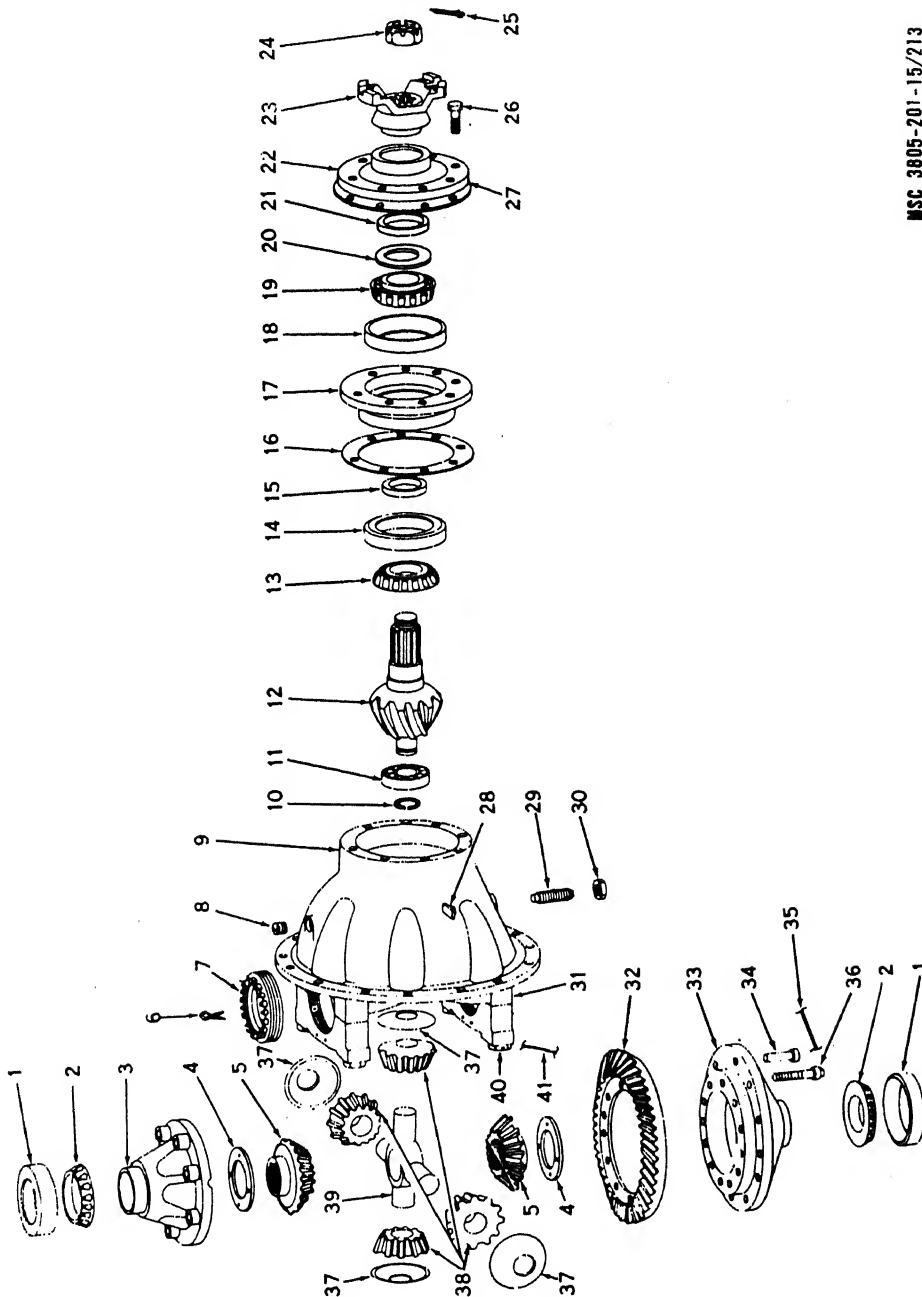
*a. General.* The differential and carrier assemblies are mounted on the rigid axle at the front of the loader and on the steering axle at the rear of the loader. Each is driven through a drive shaft from the transmission. A bevel pinion (12, fig. 213) and bevel drive gear (32) drive the differential spider and gears to provide a 5- $\frac{3}{4}$  to 1 gear reduction and differential action for the axles that drive the wheels. An adjusting screw (29) is provided to prevent the bevel gear from moving out of engagement with the bevel pinion under conditions of heavy torque load.

*b. Removal and Disassembly (fig. 213).*

- (1) Disassemble each of the final drives as directed in paragraph 265c(1) to remove the differential.

- (2) Disassemble the steering axle as directed in paragraph 262c to remove the axle shafts.
  - (3) Remove the differential from the steering axle as directed in paragraph 264c (17).
  - (4) Using a punch or chisel, match-mark each carrier cap (31) to the leg of the differential carrier on which it is mounted.
  - (5) Remove the cotter pins (6) that secure each adjusting ring (7) to the carrier cap.
  - (6) Remove the nut (30) and adjusting screw (29) from the differential carrier (9).
  - (7) Remove the lockwire (41), four screws (40), and washers that secure the carrier caps (31) to the differential carrier; remove the carrier caps, two adjusting rings (7), bearing cups (1), and the assembled differential case.
  - (8) If the original identification marks are not clear, match-mark the differential case halves with a punch or chisel to permit proper alignment at reassembly.
  - (9) Remove the lockwire (35) and cap-screws (36) that join the differential case halves; separate the differential cases (3 and 33). Remove the two thrust washers (4), differential side gears (5), four pinion thrust washers (37), differential pinions (38), and the spider (39).
  - (10) If damaged or excessively worn, press the bearing cones (2) from the plain differential case (3) and flanged differential case (33).
  - (11) If the drive gear (32) requires replacement, proceed as follows:
    - (a) Carefully center-punch each of the 12 rivets (34) in the centers of the heads.
    - (b) Drill through the head of each rivet with a  $1\frac{9}{32}$ -inch drill.
    - (c) Press out the rivets with a punch; remove the drive gear.
  - (12) Remove the cotter pin (25); hold the yoke and slinger and remove the nut (24).
  - (13) Remove the yoke and slinger (23) with a suitable puller.
  - (14) Remove the eight screws (26) that secure the cover (22) to the differential carrier; remove the assembled cover and oil seal and gasket (27). Remove the oil seal (21) and washer (20) from the cover.
  - (15) Install the screws in the three puller holes provided in the pinion cage; tighten the screws evenly to pull the pinion cage from the differential carrier. Remove the assembled pinion, cage, bearings, and shims (16).
  - (16) Press the assembled pinion and bearings from the pinion cage; remove the bearing cone (19). Remove the bearing cups (14 and 18) from the pinion cage if damaged or excessively worn.
  - (17) Remove the retaining ring (10), bearing (11), and spacer (15) from the pinion; press the bearing cone (13) from the pinion.
  - (18) Remove the plug (8) and thrust block (28) from the differential carrier (9).
- c. *Cleaning and Inspection* (fig. 213).
- (1) Thoroughly clean all parts by washing with an approved cleaning solvent; dry with compressed air. Lightly coat all bearing with clean lubricating oil.
  - (2) Inspect the roller bearings for cracks, nicks, scoring, excessive wear or looseness, and rough or binding operation.
  - (3) Inspect the bearing cups for nicks, scoring, or excessive wear. If any of the bearing cups or bearing cones are damaged or unserviceable, replace both mating parts.
  - (4) Inspect the differential side gears (5) and the differential pinions (38) for cracks, nicks, scoring, pitting, damaged splines, or excessive wear. If the gears are unserviceable, replace only as a set.
  - (5) Inspect the drive gear (32) and pinion (12) for cracks, nicks, scoring, pitting, excessive wear, or other damage; if unserviceable, replace both mating gears.
  - (6) Inspect the thrust washers (4 and 37) for scoring, excessive wear, or damage; replace the defective thrust washers in sets.





MSC 3805-201-15/213

- |    |                         |    |             |    |                  |    |                           |
|----|-------------------------|----|-------------|----|------------------|----|---------------------------|
| 1  | Bearing cup             | 12 | Pinion      | 23 | Yoke and slinger | 33 | Flanged differential case |
| 2  | Bearing cone            | 13 | Bearing cup | 24 | Nut              | 34 | Rivet                     |
| 3  | Plain differential case | 14 | Bearing cup | 25 | Cotter pin       | 35 | Lockwire                  |
| 4  | Thrust washer           | 15 | Spacer      | 26 | Screw            | 36 | Cap screw                 |
| 5  | Differential side gear  | 16 | Shim        | 27 | Gasket           | 37 | Pinion thrust washer      |
| 6  | Cotter pin              | 17 | Pinion cage | 28 | Thrust block     | 38 | Differential pinion       |
| 7  | Adjusting ring          | 18 | Bearing cup | 29 | Adjusting screw  | 39 | Spider                    |
| 8  | Plug                    | 19 | Washer      | 30 | Nut              | 40 | Screw                     |
| 9  | Differential carrier    | 20 | Oil seal    | 31 | Carrier cap      | 41 | Lockwire                  |
| 10 | Retaining ring          | 21 | Cover       | 32 | Drive gear       |    |                           |
| 11 | Bearing                 | 22 |             |    |                  |    |                           |

Figure 213. Differential, exploded view.

- (7) Inspect the differential spider (39) for cracks, nicks, scoring, or excessive wear. Replace if even the slightest wear is evident.
- (8) Inspect the differential carrier for cracks, stripped threads, or other damage.
- (9) Inspect the plain differential case (3) and flanged differential case (33) for cracks, scored or excessively worn bearing surfaces, and elongated or damaged rivet or bolt holes.
- (10) Replace all gaskets, cotter pins, lockwire, seals, and damaged or excessively worn parts.

*d. Reassembly and Installation.*

*Note.* Prior to reassembly, lubricate the oil seal and bearing cups and cones with light machine oil, and the remaining parts with differential gear oil.

- (1) Press the bearing (11, fig. 213) into position on the pinion (12); secure with the retaining ring (10). Press the bearing cone (13), with the large diameter inward, on the pinion.
- (2) Press the bearing cups (14 and 18) into position firmly against the shoulders in the pinion cage (17).
- (3) Position the spacer (15) on the pinion. Position the assembled pinion cage and bearing cups over the bearing cone on the pinion; press the bearing cone (19) into position. Measure the pinion bearing preload as follows:
  - (a) With the pinion in a press, apply a pressure of 11 tons to the bearings.
  - (b) Wrap soft wire around the pinion cage and connect the pound scale.
  - (c) Pull a straight line and read the rotating torque (not the starting torque). The rotating torque should be 5 to 15 inch-pounds (scale indication of 1 pound, 10 ounces to 5 pounds).
  - (d) If the reading does not fall within the required limits, use a thinner spacer (15) to increase the bearing preload or a thicker spacer to decrease it.
- (4) Install the oil seal (21) and washer (20) in the cover (22) and a gasket on the cover.
- (5) Position the assembled cover, oil seal,

- and washer, with the gasket, on the yoke and slinger (23).
- (6) Press the yoke and slinger into position on the pinion. Hold the yoke with a suitable tool and install the nut (24); tighten the nut to a torque of 700 to 900 foot-pounds.
- (7) Position the shims (16) and the assembled pinion and yoke on the differential carrier; secure with the eight screws (26).
- (8) If the drive gear (32) was removed from the flanged differential case, position a new drive gear and align the holes. Secure with the 12 rivets (34). Upset the rivets cold with a pressure of approximately 45 tons.
- (9) Position the four differential pinions (38) and pinion thrust washers (37) on the spider (39).
- (10) Position the thrust washer (4), differential side gear (5), assembled spider, pinions, and thrust washers, the remaining side gear (5), and the thrust washer (4) on the flanged differential case (33).
- (11) Position the plain differential case (3), taking care to align the matchmarks and the holes; temporarily secure with the four capscrews (36). Check the assembled parts for free rotation of the differential gears; if binding is noted, disassemble and check the parts for burrs or other cause.
- (12) Install the eight capscrews (36) and tighten to a torque of 94 to 102 foot-pounds. Install the lockwire (35) through the capscrews.
- (13) Press the two bearing cones (2) into their respective positions on the differential case.
- (14) Temporarily position the bearing cups (1), adjusting rings (7), and the carrier caps (31), taking care to align the matchmarks on the differential carrier (9); secure with the screws (40) and washers; tighten the screws to a torque of 345 to 370 foot-pounds. Check that the bearing cups are a hand-push fit in the carrier caps; if not a hand-push fit, rework the bores with a scraper or emery cloth. When

the proper fit is obtained, remove the screws, washers, carrier caps, bearing cups, and adjusting rings.

- (15) Position the bearing cups (1) over the bearing cones on the differential case.
- (16) Position the assembled differential case and bearings on the differential carrier; position the adjusting rings (7); turn hand-tight against the bearing cups.
- (17) Observing the match-marks, position the carrier caps (31) and tap lightly to seat. If the carrier caps do not position properly, reposition the adjusting rings to be sure they are not cross-threaded. Install the two screws (40) and washers that secure each carrier cap; tighten the screws to a torque of 345 to 370 foot-pounds.
- (18) Adjust the differential bearing preload and check for runout as follows:
  - (a) Mount a dial indicator on the differential carrier so that the indicator sensing point is resting against the back surface of the drive gear (32) as shown in figure 214.
  - (b) Loosen the adjusting ring (7, fig. 213) on the side opposite the gear only sufficiently to notice end play on the indicator.
  - (c) Tighten the same adjusting ring just enough so that no end play is indicated when using the pry bars as shown in figure 215.
  - (d) To check for runout, slowly rotate the drive gear through 360° while observing the indicator; if the total runout exceeds 0.008 inch, disassemble the differential and check for the cause.
  - (e) When the runout is within the 0.008-inch limit, preload the differential bearings by advancing each adjusting ring one notch.
  - (f) Secure each of the adjusting rings (7, fig. 213) with the cotter pins (6).
- (19) Adjust the drive gear backlash as follows:
  - (a) If the original gears are used, the backlash adjustment should be made the same as before disassembly. Care must be taken not to correct

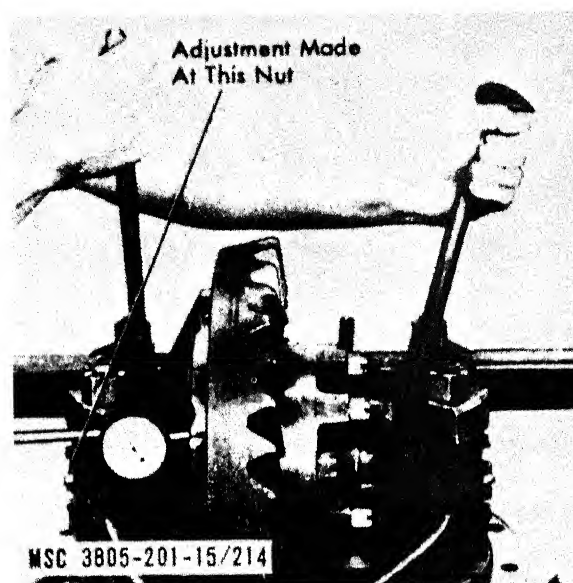


Figure 214. Adjusting differential bearing preload.

for backlash to a point where the teeth of the pinion overlap the worn ridges in the drive gear. With new gears, the backlash should be 0.006 to 0.012 inch.

- (b) Mount a dial indicator on the differential carrier so that the indicator sensing point is resting against the side of the drive gear, as shown in figure 215. Hold the yoke mounted

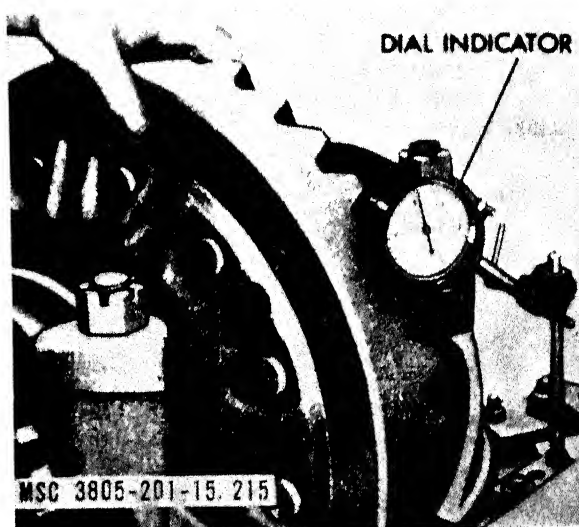
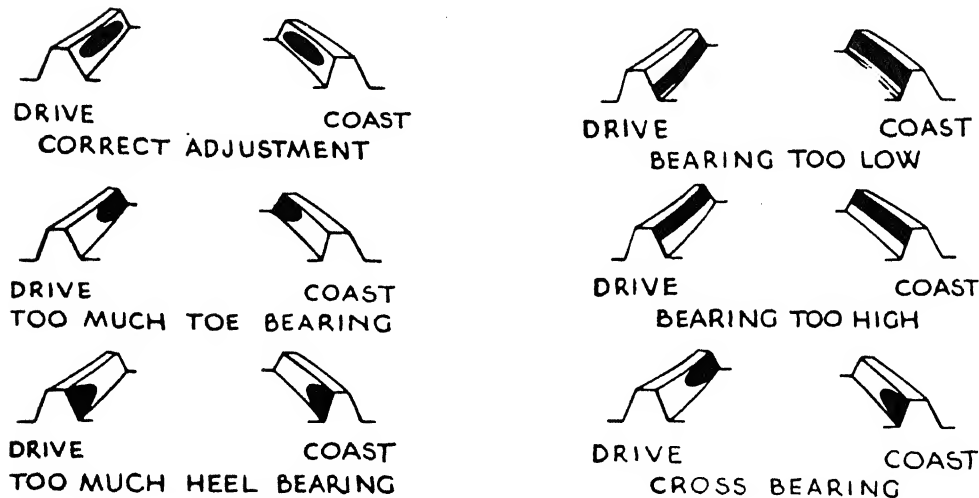


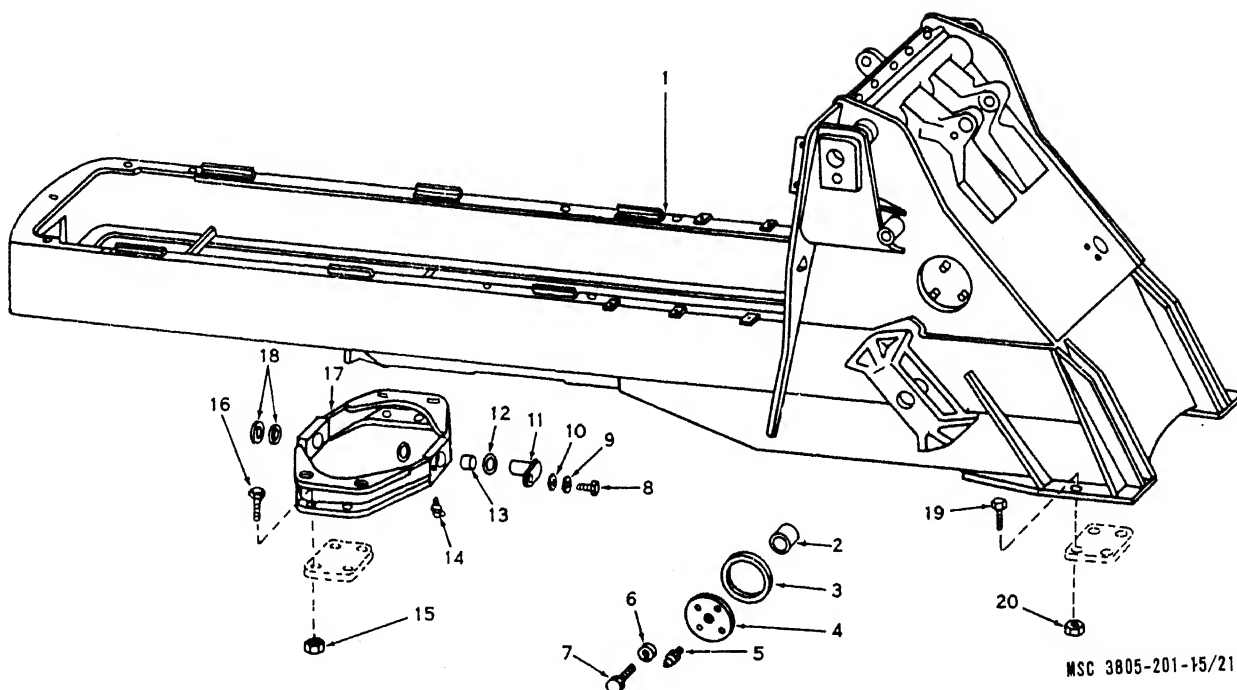
Figure 215. Using dial indicator to set correct backlash.



MSC 3805-201-15/216

Figure 216. Location, size, and shape of bevel gear tooth contact.

- on the pinion stationary and attempt to rotate the drive gear back and forth; note the backlash as registered on the dial indicator.
- (c) If the backlash is greater than the requirement, loosen the adjusting ring in front of the drive gear, and tighten the adjusting ring behind the drive gear an equal amount. If the backlash is less than the requirement, loosen the adjusting ring behind the drive gear, and tighten the adjusting ring in front of the drive gear an equal amount. Recheck the backlash and readjust as required.
  - (20) Check and adjust the drive gear tooth contact as follows:
    - (a) Paint about 12 teeth of the drive gear lightly with oiled red lead.
    - (b) Using a wrench, slowly turn the pinion (12, fig. 213) while applying a small amount of resistance to the rotation of the drive gear (32) with a flat steel bar. Turn the pinion until the teeth have passed across the painted teeth on the drive gear.
    - (c) Examine the impressions on the painted teeth of the drive gear, and compare them to the impressions shown in figure 216. A correct impression is centered on the side of the tooth and favors the toe of the gear tooth extending  $\frac{1}{2}$  to  $\frac{2}{3}$  the tooth length toward the heel.
    - (d) If the impressions on the drive gear teeth show that the contact surface is too far toward the toes (the inner end of the gear teeth), move the drive gear slightly away from the pinion by loosening the adjustment ring behind the gear and tightening the adjustment ring in front of the gear an equal amount. Adjust the backlash as directed in (i) below.
    - (e) If the impressions on the drive gear teeth show that the contact surface is too far toward the heels (the outer end of the gear teeth), move the drive gear slightly toward the pinion by loosening the adjustment ring in front of the gear and tightening the adjustment ring behind the gear an equal amount. Adjust the backlash as directed in (i) below.
    - (f) If the impressions on the drive gear teeth show that the contact surface is too low on the teeth, move the pinion slightly away from the drive gear by adding shims (16, fig. 213) between the pinion cage and differ-



MSC 3805-201-15/217

- |                       |                |                        |                     |
|-----------------------|----------------|------------------------|---------------------|
| 1 Main frame          | 6 Lockwasher   | 11 Pinlock             | 16 Capscrew         |
| 2 Bushing             | 7 Capscrew     | 12 Cord ring           | 17 Cradle           |
| 3 Gasket              | 8 Capscrew     | 13 Bushing             | 18 Spacer           |
| 4 Plate               | 9 Lockwasher   | 14 Lubrication fitting | 19 Capscrew         |
| 5 Lubrication fitting | 10 Flat washer | 15 Self-locking nut    | 20 Self-locking nut |

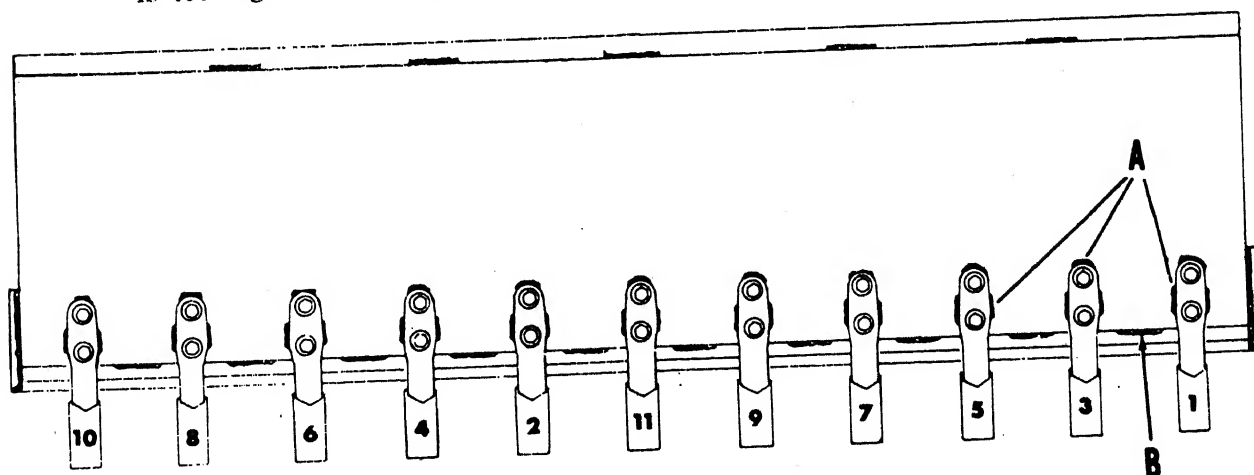
Figure 217. Main frame, exploded view.

ential carrier as required. Adjust the backlash as directed in (19) above.

- (g) If the impressions on the drive gear teeth show that the contact surface is too high on the teeth, move the

pinion slightly toward the drive gear by removing the shims (16) from between the pinion cage and differential carrier. Adjust the backlash as directed in (19) above.

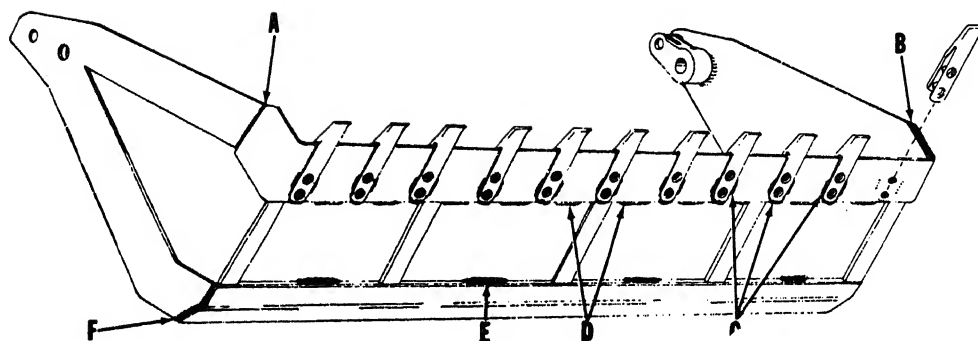
- (h) After each adjustment, recheck the



MSC 3805-201-15/218

A—Top welds

Figure 218. Bucket clam welds.



MSC 3805-201-15/218A

B—Bottom welds

Figure 218—Continued.

tooth contact as directed in subparagraphs (1) through (3) above. Several adjustments may be required to secure correct contact and backlash.

- (i) When the drive gear has been moved to correct for tooth contact near the toes or heels of the drive gear, the backlash is then corrected by moving the pinion. Determine the backlash requirement as directed in (19) (a) above and measure the backlash as directed in (19) (b) above. If the backlash is greater than the requirement, remove the shims between the pinion cage and the differential carrier; if less than the requirement, add shims. Recheck the backlash and tooth contact.
- (21) When the proper tooth contact has been obtained, the backlash adjusted, and the bearing preload set, install the lockwire (41) through the screws that secure the carrier caps. Tighten the eight screws (26) that secure the pinion bearing cage to the differential carrier to a torque of 80 to 91 foot-pounds.
- (22) Position the differential carrier so that the back surface of the drive gear is upward. Position the thrust block (28) on the back surface of the drive gear and rotate the drive gear until the thrust block is aligned with the adjusting screw (29). Tighten the adjusting screw firmly against the thrust block; back off the adjusting screw  $\frac{1}{4}$  turn to secure a correct clearance of 0.010

to 0.015 inch; lock with the nut (30). Rotate the drive gear through  $360^\circ$  to be sure there is no binding.

- (23) Install the differential in the rigid axle and install the final drives as directed in paragraph 263e.
- (24) Install the differential in the steering axle and install the universal joints and reassemble the final drives as directed in paragraph 267e.

## 267. Main Frame (fig. 217)

### a. Disassembly.

- (1) Remove the steering axle as directed in paragraph 264b.
- (2) Remove the two capscrews (8), lockwashers (9), and flat washers (10) that secure the bolster pinlocks (11) to the main frame. Block up under the cradle (17) and drive out the pinlocks to release the cradle. Remove the cradle and cord rings (12).

### b. Cleaning and Inspection.

- (1) Inspect the main frame for cracks, breaks, dents, stripped threads, and excessively scratched or worn painted surfaces.
- (2) Weld any cracks or breaks using A.W.S. type E-7018 electrodes.
- (3) Retap holes if the threads are stripped or damaged.
- (4) Inspect the bushings (2) for wear or scoring. If damaged, drive out the old bushings and drive new bushings into place.
- (5) Straighten any kinks or dents.

- (6) Inspect the cradle for cracks or distortion. Weld the cracked areas. Check the bushings (13) in the bolster for wear or scoring. If damaged, drive out the old bushings and drive new bushings into place.
- (7) Repaint surfaces that are excessively worn or scratched.
- (8) Repair or replace parts that have deteriorated or corroded excessively; be sure to check the battery box and surrounding area.

*c. Reassembly.*

- (1) Position the bolster on the main frame with the cord rings and spacers in place; secure by driving in the bolster pinlocks (11). Secure each pinlock with a capscrew (8), lockwasher (9), and flat washer (10).
- (2) Install the steering axle as directed in paragraph 262f.

## 268. Replacement of Bucket Teeth and Cutting Edge

*a.* If the cutting edge (1, fig. 108) of the bucket clam is excessively worn or damaged and requires replacement, proceed as follows:

- (1) When the bucket assembly is not being completely disassembled, disconnect the clam cylinders (24) and remove the clam as directed in paragraph 219b. Remove the teeth from the clam.
- (2) If the teeth are welded, burn off the welds designated A in A, figure 218, on the upper side of the teeth, with a torch. Remove the welds in the order numbered in the illustration to overcome excessive heating of the clam floor. Turn the clam over, and using the same sequence, burn off the welds designated C in A, figure 218 on the underside of the teeth; knock the teeth off the cutting edge.
- (3) Burn off the side welds designated A and B in A, figure 218 from the cutting edge.
- (4) With the clam in an upright position, burn off the welds designated B in figure 218, flush with the edge of the bottom plate; use a wedge to break the remaining welds designated D in B, figure 218; remove the cutting edge.

- (5) Grind all old welds from the clamp so that the mounting surfaces are smooth and clean.

*b.* Install the cutting edge on the clam as follows:

*Note.* Use class 11016 or E12016 electrodes to weld the bucket parts.

- (1) Aline the holes and clamp the cutting edge (1, fig. 108) in position; tack-weld the cutting edge to the clam in several places.
- (2) Secure the cutting edge with the welds designated B in A, figure 218 and A, B, and D in B, figure 218.
- (3) If required, drill out the holes for the teeth with a  $1\frac{3}{16}$ -inch drill.
- (4) Position the nine assembled teeth shanks and tips on the cutting edge of the clam; secure each with the two screws (44 and 45, fig. 108) and nuts (47). Tighten the nuts to a torque of 390 to 440 foot-pounds. If the teeth are to be welded, apply the welds designated A in figure 218 to the upper side of each tooth in the sequence shown by the numbers on the teeth in the illustration. Apply the welds designated C in B, figure 218 to the bottom side of the teeth following the same sequence.

## 269. Turbocharger

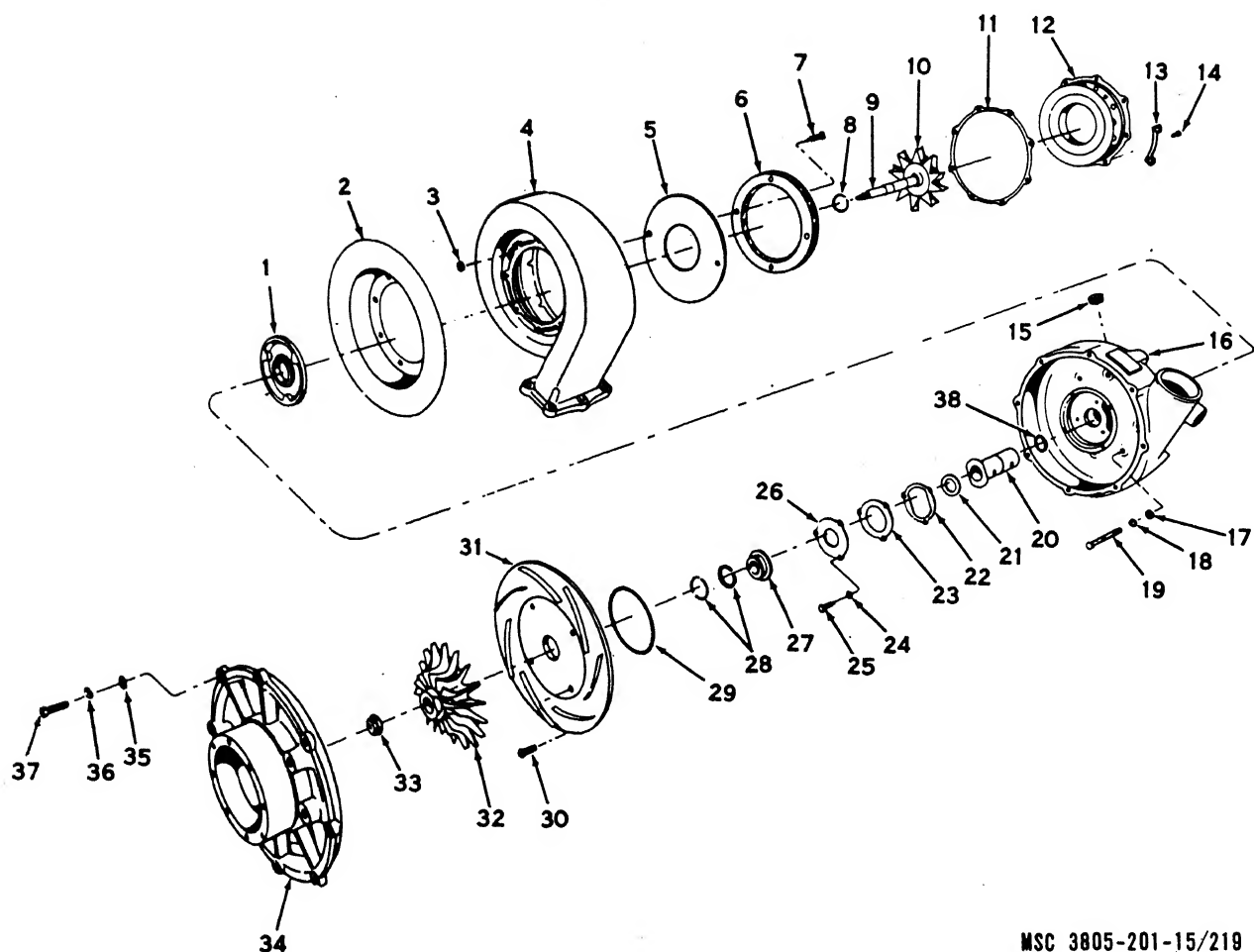
*a. General.*

- (1) The exhaust gas turbocharger is used to force additional air into the engine combustion chambers so that the engine can burn more fuel. This enables the engine equipped with a turbocharger to develop more horsepower than a naturally aspirated engine.
- (2) The turbocharger consists of a turbine wheel and a centrifugal blower, separately encased, but mounted on and rotating with a common shaft. The turbine side of the turbocharger mounts to the exhaust manifold outlet flange, and the blower side connects with the air intake manifold. Lubricating fluid is supplied by the engine lubrication system.

*b. Removal and Disassembly (fig. 219).*

- (1) Remove the turbocharger from the engine as directed in paragraph 163c.





MSC 3805-201-15/219

1 Oil seal plate	11 Shim	21 Thrust washer	30 Screw
2 Outer heat shield	12 Exhaust casing	22 Bearing retainer	31 Diffuser plate
3 Nut	13 Lockplate	23 Thrust bearing spacer	32 Compressor wheel
4 Turbine casing	14 Screw	24 Lockwasher	33 Nut
5 Inner heat shield	15 Plug	25 Screw	34 Front plate
6 Nozzle ring	16 Main casing	26 Outboard thrust bearing	35 Flat washer
7 Screw	17 Flat washer	27 Oil seal sleeve	36 Lockwasher
8 Piston ring seal	18 Lockwasher	28 Piston ring seal	37 Screw
9 Rotor shaft	19 Screw	29 Preformed packing	38 Preformed packing
10 Turbine wheel	20 Floating bearing		

Figure 219. Turbocharger, exploded view.

**Caution:** Thoroughly clean the exterior of the turbocharger before starting disassembly.

- (2) Bend the tabs of the lockplates (13) to release the screws (14). Remove the screws and lockplates that secure the exhaust casing (12) to the turbine casing (4); remove the exhaust casing and shims (11).
- (3) Remove the eight screws (37), lockwashers (36), and flat washers (35) that secure the front plate (34) to the

main casing (16); remove the front plate.

- (4) Remove the nut (33) from the end of the rotor shaft (9); press the shaft from the compressor wheel (32). Remove the compressor wheel and the assembled turbine wheel (10) and rotor shaft (9).
- (5) Remove the four screws (30) that secure the diffuser plate (31) to the main casing; remove the diffuser plate.
- (6) Remove the preformed packing (29)

and oil seal sleeve (27) from the diffuser plate.

- (7) Remove the three screws (25) and lockwashers (24) that secure the outboard thrust bearing (26) to the main casing (16); remove the bearing, thrust bearing spacer (23), and thrust washer (21); remove the floating bearing (20). Remove the preformed packing (38) from the bearing.
- (8) Remove the eight screws (19), lockwashers (18), and flat washers (17) that secure the main casing to the turbine casing. Remove the main casing and outer heat shield (2) if necessary, tap lightly with a plastic hammer to loosen. Remove the outer heat shield.
- (9) Remove the four nuts (3) and screws (7) that secure the nozzle ring (6) to the turbine casing; remove the nozzle ring and inner heat shield (5).
- (10) Remove the oil seal plate (1) using a bar inserted through the oil drain passages. Tap on the bar to dislodge the oil seal plate and piston ring seal (8).
- (11) Remove the four screws (7) and nuts (3) that secure the nozzle ring (6) to the turbine casing (4); remove the nozzle ring and inner heat shield (5).

*c. Cleaning and Inspection (fig. 219).*

- (1) Immerse all parts in a suitable solvent that will remove the glazed carbon deposits without attacking the metal; brush with a soft bristle brush. Steam-clean parts if necessary; dry with compressed air.

**Caution:** Do not use caustic solutions or any type of solvent that will attack aluminum, stellite, or Ni-resist alloys.

- (2) Inspect the front cover for cracks or deep scoring. Slight nicks or scratches can be removed with a fine polishing cloth. Replace if deeply scored by the compressor wheel.
- (3) Inspect the nozzle ring for cracks or damaged vanes.
- (4) Inspect the diffuser plate for cracks, broken vanes, scoring, or other damage.
- (5) Inspect the main casing for cracks, stripped threads, or wear of the bear-

ing bore to more than 1.3130-inch inside diameter.

- (6) Inspect the impeller for cracks, scoring, or other damage.
- (7) Inspect the rotor and shaft for cracks, scoring, wear of the bearing journal to less than 0.9376-inch outside diameter, stripped threads, or other damage.
- (8) Inspect the floating bearing for wear or scoring. Replace if damaged or if inside diameter is greater than 0.9398 inch or if outside diameter is worn to less than 1.0308 inches.
- (9) Inspect the turbine casing for stripped threads or cracks; slight cracks around the center holes or the bridge of the mounting flange are not cause for replacement. Cracks wider than  $\frac{1}{64}$  inch at these points should be welded.
- (10) The rotor assembly is a balanced assembly which consists of the turbine wheel (10), rotor shaft (9), compressor wheel (32), and nut (33); therefore, if any part is damaged, the complete assembly must be replaced.
- (11) Inspect the inner shield for cracks or distortion, and the outer shield for cracks or dents; straighten dents in outer shield and reuse.
- (12) Replace seal, preformed packings, and damaged and excessively worn parts.

*d. Reassembly and Installation (fig. 219).*

- (1) Position the inner heat shield (5) in the turbine casing (4) with the concave area down and the holes aligned with those in the casing.
- (2) Position the nozzle ring (6) over the inner shield with the counterbored holes up and aligned with the holes in the casing. Apply antiseize compound to threads of the screws (7). Install the four screws and tighten to a torque of 100 inch-pounds.
- (3) Check the flatness of the nozzle ring with the turbine casing face at four points, using a depth gage. If there is a variation greater than 0.004 inch, disassemble the parts and check for burs; reassemble as in (2) above and recheck the flatness.
- (4) Apply antiseize compound to the ends of the screws protruding at the back

- of the turbine casing; install the four nuts (3). Hold the screws to prevent loosening; tighten the nuts to a torque of 100 inch-pounds. Lock-wire the nuts.
- (5) Install the piston ring seal (8) in the oil seal plate (1). Place a circle of opaque material, just slightly smaller than the seal plate bore, against the ring seal. Hold the assembled parts up to a strong light. Check the outside edge of the piston ring seal for light passage. If any light passes between the ring seal and seal plate, the plate is burred, preventing the ring seal from seating. Remove burs and make sure that the ring seal seats properly. Remove the ring seal for later assembly.
  - (6) Apply lubriplate to the seal plate; press the oil seal plate into the main casing (16).
  - (7) Position the outer heat shield (2) and main casing on the turbine casing; secure with the eight screws (19), lockwashers (18), and flat washers (17). Apply anti-seize compound to screws before installing; tighten the screws to a torque of 84 inch-pounds.
  - (8) Install the preformed packing (38) in the floating bearing (20). Install the floating bearing in the main casing (16) with the oil hole toward the oil drain connection. Install the bearing retainer (22), thrust washer (21), thrust bearing spacer (23), and outboard thrust bearing (26) on the main casing; secure with the three screws (25) and lockwashers (24), but do not tighten.
  - (9) Insert one finger into the opposite side of the floating bearing (20) and turn the bearing in either direction as far as it will go. Tighten one screw (25) snugly. Evenly tighten the other two screws. Torque all screws to 100 inch-pounds. Check that the bearing turns easily in either direction.
  - (10) With a dial indicator, check the depth from the mounting flange of the turbine casing (4) to the nozzle ring (6) in four places, evenly spaced. Readings must not vary more than 0.004 inch.
  - (11) Leave the dial indicator set at zero and check the distance from the bottom surface of the exhaust casing to the mounting flange surface. If the indicator shows that there will be a crush of 0.000 to 0.007 inch when the exhaust casing is installed, no shims (11) are necessary. If the crush exceeds this amount, install shims (0.005, 0.010, or 0.015 inch) to leave a crush of 0.000 to 0.007 inch.
  - (12) Apply a light coat of lubriplate to the piston ring seal (8) to hold it in position. Install the piston ring seal in the oil seal plate. The fit of these parts was checked in (5) above.
  - (13) Apply lubricating fluid to the bearing surface of the rotor shaft (9) and carefully insert the shaft through the piston ring seal.
  - (14) Position shims (11), if required, on the turbine casing (4) and position the exhaust casing (12) on the turbine casing. Coat the screws (14) with anti-seize compound and install the lockplates (13) and screws. Torque to 12 foot-pounds and bend up the corners of the lockplates to secure the screws.
  - (15) Use a depth indicator to check the turbine end clearance, resting the point of the indicator against the hub of the turbine wheel. Move the rotor assembly up and down to the limits of travel and check end clearance. End clearance must be between 0.015 and 0.042 inch. If necessary, add or remove shims that were installed in (14) above. If correct clearance cannot be attained, the nozzle ring and/or the exhaust casing is warped; replace the defective part.
  - (16) Install the preformed packing (29) on the diffuser plate (31). Install the two-part piston ring seal (28) in the oil seal sleeve (27) so that the ring gaps are 180 degrees apart. Apply vaseline on the ring and sleeve center. Press the ring and sleeve assembly into the diffuser plate using finger pressure only.
  - (17) Check the balance marks on the shaft

and thrust washer. Assemble the diffuser plate and sleeve assembly on the end of the shaft with the balance mark on the sleeve alined with the mark on the end of the shaft and thrust washer.

- (18) Aline the holes in the diffuser plate with the holes in the main casing; install the screws (30) and tighten to a torque of 100 inch-pounds. Secure the screws by staking the screws to the diffuser plate.
- (19) Preheat the compressor wheel. Apply lubriplate to the end of the rotor shaft. Position the assembled unit on an arbor press, blocking up under the turbine wheel. Aline the balance marks of the compressor wheel (32) with those on the shaft and press the compressor wheel onto the shaft far enough to install the nut (33). Install the nut.
- (20) Position the front plate (34) on the main casing (16) and secure with at least three screws (37). Invert the assembly and remove the exhaust casing (12). Use a depth indicator to register the end clearance of the rotor shaft, moving the rotor assembly from one end to the other. End clearance must be 0.014 to 0.025 inch.
- (21) Invert the assembly and remove the front plate (34). Remove the nut (33) and press the compressor wheel on the rotor shaft until it bottoms. Install the nut (33), holding the rotor from

turning with a wrench on the flats on the end of the shaft. Tighten the nut until snug. Advance the nut until the balance marks on the nut aline with those on the shaft.

*Note.* In most cases, the compressor wheel will rub on the diffuser plate until the front plate is installed.

- (22) Position the front plate (34) on the assembly; secure with eight screws (37), lockwashers (36), and flat washers (35). Tighten the screws to a torque of 84 inch-pounds. Make sure the rotor assembly rotates freely after installing the front plate.
- (23) Position the exhaust casing (12) on the assembly; secure with the lockplates (13) and screws (14). Bend up the lockplates to retain the screws.
- (24) Again check end clearance using a depth indicator. End clearance must be between 0.003 and 0.010 inch.
- (25) Check the clearance between the tip of the compressor wheel vanes and the front plate with a feeler gage. Push the compressor wheel toward the feeler gage to minimize the clearance. Clearance must be 0.007 inch minimum.
- (26) Check the clearance between the turbine wheel and the exhaust casing with a feeler gage. Push the turbine wheel toward the feeler gage to minimize the clearance. Clearance must be 0.012 inch minimum.
- (27) Install the turbocharger as directed in paragraph 163e.

## CHAPTER 5

### DEMOLITION, SHIPMENT, AND LIMITED STORAGE

#### Section I. DEMOLITION

##### 270. General

When capture or abandonment of the loader to any enemy is imminent, the responsible unit commander must make the decision either to destroy the equipment or to render it inoperative. Based on this decision, orders are issued which cover the desired extent of destruction. Whatever method of demolition is employed, it is essential to destroy the same vital parts of all loaders and all corresponding repair parts.

##### 271. Demolition to Render the Loader Inoperative

a. *Mechanical means.* Use a sledge hammer, pick, axe, crowbar, or any other heavy tool or object which may be readily available to destroy the following:

- (1) All accessories such as the generator, starter, regulator, battery, and fuel pump.
- (2) All castings such as the engine block on both sides, manifolds, and other vital parts of the engine.

*Note.* The above steps are the minimum requirements for this method.

- (3) The instrument panel, steering wheel, hydraulic controls, hydraulic cylinders, and tires.

b. *Misuse.* Perform the following steps to render the loader inoperative:

- (1) Drain the radiator and oil pan.
- (2) Throw sand, gravel, dirt, broken glass, or other like substances in the crankcase, hydraulic reservoir, fuel tank, and radiator.
- (3) Start the engine and let it run at maximum speed until failure occurs.
- (4) Puncture the fuel tank and hydraulic oil tank.
- (5) Cut all cables, hose, and electrical wiring.
- (6) Pour gasoline over the entire machine, if possible, and ignite.

*Note.* The above steps are the minimum requirements for this method.

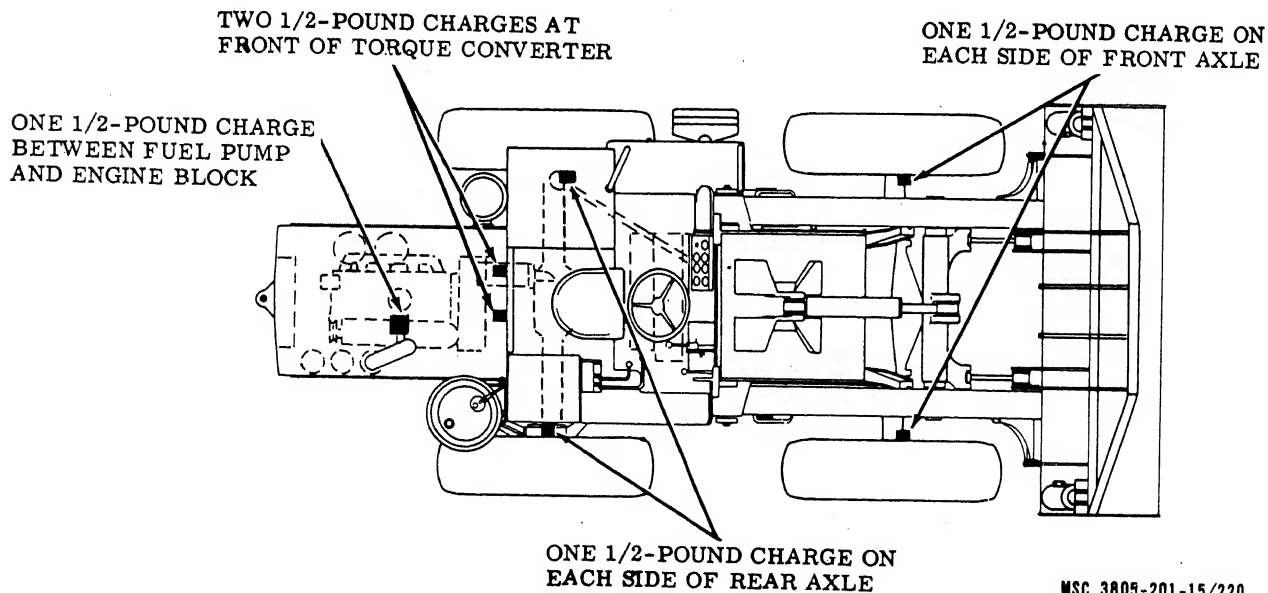


Figure 220. Placement of explosive charges.

## 272. Demolition by Explosives or Weapons Fire

a. *Explosives.* Place as many of the charges (fig. 220) as the situation permits and detonate them simultaneously with a detonating cord and suitable detonator.

b. *Weapons Fire.* Fire on the loader with the heaviest practical weapons available. If possible, aim for the engine block from either side.

## 273. Other Demolition Methods

a. *Scattering and Concealment.* Remove all easily accessible vital parts such as the battery, generator, generator regulator, starter, and filters and scatter them throughout the underbrush or tall grass, bury them in dirt or sand, or throw them in a lake, well, or other body of water.

b. *Burning.* Pack rags, clothing, canvas, or brush on and around the loader. Saturate this

packing with gasoline or oil and ignite.

c. *Submersion.* Totally submerge the loader in a body of water to provide concealment and water damage. A body of salt water will do greater damage to metal parts than submersion in a body of fresh water.

## 274. Training

All operators should receive thorough training in the destruction of the loader. Refer to FM5-25. Simulated destruction, using all the methods listed above, should be included in the operator training program. It must be emphasized in training that demolition operations usually are necessitated by critical situations when the time available for carrying out destruction is limited. For this reason, it is necessary that operators be thoroughly familiar with all methods of destruction of the equipment, and be able to carry out demolition instructions without reference to this or any other manual.

# Section II. SHIPMENT AND LIMITED STORAGE

## 275. Preparing Equipment for Shipment Within Zone of Interior

a. *General.* This paragraph provides instructions for preparation of the loader for domestic shipment. Preservation will be accomplished in sequence that will not require the operation of previously preserved components.

b. *Inspection.* Examine the loader for any unusual condition such as damage or missing components. Inspect the loader in accordance with steps outlined in quarterly preventive maintenance services (par. 58). All deficiencies and shortcomings will be recorded on DA Form 2404 together with corrective action taken.

c. *Cleaning and Drying.* Thoroughly clean and dry the loader by the most applicable approved methods. Refer to TM 38-230 for approved cleaning and drying methods.

d. *Painting.* Repaint all surfaces from which the paint has been removed or damaged. Refer to TB ENG 60 for detailed treatment and painting instructions.

e. *Depreservation Guide.* Record depreservation instructions on DA Form 2258 (Depreservation Guide of Engineer Equipment) concurrently with the preservation of each loader. Record any peculiar requirements in blocks 27 through 33. Place the completed depreservation

guide in a waterproof envelope marked "Depreservation Guide" and secure in a conspicuous location on or near the operator's controls.

f. *Cooling System.* Make sure that the cooling system is filled to the proper level with a clean solution of 50 percent water and 50 percent ethylene glycol conforming to type 1 of Specification O-A-548.

*Note.* It is not necessary to drain and refill cooling system if the solution is clean and checks to a  $-25^{\circ}$  F. If temperatures below  $-25^{\circ}$  F. are expected, antifreeze conforming to Specification MIL-C-11755 will be used in its undiluted condition.

g. *Lubrication.* Lubricate the loader in accordance with current lubrication order. Make sure that the crankcase is filled to the proper level. Operate the engine at a fast idle long enough to bring it up to its operating temperature and insure complete lubrication of bearings, gear, etc. Leave the oil in the crankcase.

h. *Air Cleaner.* Remove, clean, and reinstall air cleaner.

i. *Fuel tank.* If the fuel tank is empty, fog or spray with preservative oil, type P-10, grade 2 conforming to Specification MIL-L-21260. Otherwise, it is not necessary to drain or preserve the fuel tank.

j. *Disassembly, Disassembled Parts, and Basic Issue Items.*

- (1) Disassembly will be limited to the removal of components and projecting parts that tend to increase the overall profile of the loader or are subject to pilferage or damage.
- (2) Disassembled parts will be packed with the basic issue items in the tool box, if possible. Otherwise, parts will be packed in a suitable container(s) and secured to the equipment to prevent loss or damage.

*k. Exterior Surfaces.* Coat any exposed machined ferrous metal surfaces with preservative (P-6) conforming to Specification MIL-C-11796. If preservative is not available use automotive and artillery grease (GAA) as specified on the Lubrication Order.

*l. Batteries.* Fill and fully charge the batteries, secure in battery compartment. Disconnect the battery cables and secure in a manner that will prevent contact with terminals.

*m. Sealing of Openings.* Seal all openings that will permit direct entry of water into the interior of the engine and other components of the loader with pressure sensitive tape conforming to type III, Class 1, of Specification PPP-T-60.

*n. Pneumatic Tires.* Inflate pneumatic tires to normal operating pressure.

*o. Marking.* Mark the loader for shipment in accordance with requirements of Standard MIL-STD-129.

## **276. Loading Equipment for Shipment**

*a. Loading.* Refer to paragraph 6 and load the loader on the flatcar.

*b. Blocking.* Refer to paragraph 6 and block the loader on the flatcar.

## **277. Preparing Equipment for Storage**

*a. General.* This paragraph provides instructions for preparation of the loader for limited storage (not to exceed 6 months). Refer to AR 743-505.

*b. Inspection.* Refer to paragraph 275b.

*c. Cleaning and Drying.* Refer to paragraph 275c.

*d. Painting.* Refer to paragraph 275d.

*e. Depreservation Guide.* Refer to paragraph 275e.

*f. Cooling System.* Refer to paragraph 275f.

*g. Lubrication.* Refer to paragraph 275g.

*h. Air Cleaner.* Refer to paragraph 275h.

*i. Fuel Tank.* Drain fuel tank and fog or

spray interior with type P-10, grade 2, engine preservative oil conforming to Specification MIL-L-21260.

*j. Disassembly, Disassembled Parts, and Basic Issue Items.* Refer to paragraph 257j.

*k. Exterior Surfaces.* Refer to paragraph 275k.

*l. Batteries.* Refer to paragraph 275l.

*m. Sealing Openings.* Refer to paragraph 275m.

*n. Pneumatic Tires.*

(1) When the loader is to be placed in limited storage for over 90 days, block the loader to remove all weight from the tires. Deflate tires to two-thirds normal pressure.

(2) When the loader is not blocked up, inflate tires to normal pressure.

*o. Weatherproofing.*

(1) Store the loader under cover if space is available.

(2) When outdoor storage is necessary:

(a) Store the loader on the most suitable hardstanding or natural surface available.

(b) Provide protection against the elements by improvised cover or seals.

## **278. Inspection and Maintenance of Equipment in Storage**

*a. Inspection.* When the loader has been placed in limited storage, all scheduled preventive maintenance services, including inspection, shall be suspended and preventive maintenance inspection shall be performed as specified herein. Refer to AR 743-505.

*b. Worksheet and Preventive Maintenance.* Perform quarterly preventive maintenance services when the loader is initially placed in limited storage and every 90 days thereafter. Record all deficiencies and shortcomings, together with corrective action taken, on DA Form 2404. Required maintenance will be performed promptly to insure that the loader is mechanically sound and ready for immediate use.

*c. Operation.* At time of quarterly inspection and maintenance, operate the loader long enough to bring it up to operating temperature and insure complete lubrication of all bearings, gears, etc. After each operating period, preserve the loader as outlined in paragraph 277.



## APPENDIX I

### REFERENCES

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#### 1. Dictionaries of Terms and Abbreviations

- AR 320-5 Dictionary of United States Army Terms.  
AR 320-50 Authorized Abbreviations and Brevity Codes.

#### 2. Fire Protection

- SB 5-111 Extinguisher, Fire, Monobromotrifluormethane (CB<sub>3</sub>Br) Charged.  
TM 5-687 Repair and Utilities: Fire Protection Equipment and Appliances: Inspections, Operations and Preventive Maintenance.  
TM 9-1799 Ordnance Maintenance, Fire Extinguisher.

#### 3. Lubrication

- LO 5-3805-201-15 Lubrication Order, Loader, Scoop Type: Diesel Engine; 4 Wheel Drive, Rear Wheel Steerable Pneumatic Tires; 2½ Cu. Yd.; W/Multi-Segment Bucket (Frank G. Hough Model H-90CM) W/Engine Cummins Model JT-6-B1.

#### 4. Painting

- TB ENG 60 Preservation and Painting of Serviceable Corps of Engineer Equipment.

#### 5. Preventive Maintenance

- AR 750-5 Organization, Policies and Responsibilities for Maintenance Operation.  
TB ENG 347 Winterization Techniques for Engineer Equipment.  
TM 5-764 Electric Motor and Generator Repair.  
TM 9-207 Operation and Maintenance of Ordnance Material in Extreme Cold (0° to -65° F.).  
TM 9-6140-200-15 Operation and Organizational, Field and Depot Maintenance: Storage Batteries, Lead-Acid Type.  
TM 38-750 Army Equipment Record System and Procedures.

#### 6. Publication Indexes

- DA Pam 108-1 Index of Army Motion Pictures, Film Strips, Slides, and Phono-Recordings.  
DA Pam 310-1 Index of Administrative Publications.  
DA Pam 310-2 Index of Blank Forms.  
DA Pam 310-3 Index of Doctrinal, Training, and Organizational Publications.  
DA Pam 310-4 Index of Technical Manuals, Technical Bulletins, Supply Manuals (types 4, 6, 7, 8, and 9) Supply Bulletins, Lubrication Orders, and Modification Work Orders.  
DA Pam 310-5 Index of Graphic Training Aids and Devices.  
DA Pam 310-25 Index of Supply Manuals—Corps of Engineers.

#### 7. Radio Interference Suppression

- TM 11-483 Radio Interference Suppression.

#### 8. Shipment and Limited Storage

- AR 743-505 Limited Storage of Engineers Mechanical Equipment.  
TM 9-200 General Packaging Instructions for Ordnance General Supplies.  
TM 38-230 Preservation, Packaging, and Packing of Military Supplies and Equipment.

## **9. Supply Publications**

- SM10-C9100-SL Petroleum, Petroleum-Base Products and Related Material.  
TM 5-3805-201-20P Organizational Maintenance Repair Parts and Special Tools Lists.  
TM 5-3805-201-35P Field and Depot Maintenance Repair Parts and Special Tools List.

## **10. Training Aids**

- FM 5-25 Explosive and Demolitions.  
FM 21-5 Military Training.  
FM 21-6 Techniques of Military Instruction.  
FM 21-30 Military Symbols.

## APPENDIX II

### MAINTENANCE ALLOCATION

#### Section I. INTRODUCTION

##### 1. General

This section contains explanations of all maintenance and repair functions authorized the various echelons. Section II contains the maintenance allocation chart.

##### 2. Maintenance

Maintenance is any action taken to keep materiel in a serviceable condition or to restore it to serviceability when it is unserviceable. Maintenance of materiel includes the following:

*a. Service.* To clean, preserve, and replenish fuel and lubricants.

*b. Adjust.* To regulate periodically to prevent malfunction.

*c. Inspect.* To verify serviceability and detect incipient electrical or mechanical failure by scrutiny.

*d. Test.* To verify serviceability and detect incipient electrical or mechanical failure by use of special equipment such as gages, meters, and the like.

*e. Replace.* To substitute serviceable assemblies, subassemblies, and parts for unserviceable component.

*f. Repair.* To restore an item to serviceable condition through correction of a specific failure or unserviceable condition. This function includes, but is not limited to, inspecting, cleaning, preserving, adjusting, replacing, welding, riveting, and straightening.

*g. Align.* To adjust two or more components of an electrical system so that their functions are properly synchronized.

*h. Calibrate.* To determine, check, or rectify the graduation of an instrument, weapon, or weapons system, or components of a weapons system.

*i. Overhaul.* To restore an item to completely serviceable condition as prescribed by service-

ability standards developed and published by heads of technical services. This is accomplished through employment of the technique of "Inspect and Repair Only as Necessary" (IROAN). Maximum utilization of diagnostic and test equipment is combined with minimum disassembly of the item during the overhaul process.

##### 3. Explanation of Columns

*a. Functional Group.* The functional group is a numerical group set up on a functional basis. The applicable functional grouping indexes (obtained from the United States Army Mobility Command) are listed on the maintenance allocation chart in the appropriate numerical sequence. These indexes normally are set up in accordance with their function and proximity to each other.

*b. Components and Related Operation.* This column contains the functional grouping index heading, subgroup heading, and a brief description of the part starting with the noun name. It also designates the operations to be performed such as service, adjust, inspect, test, replace, repair, and overhaul.

*c. Echelons of Maintenance.* This column contains the various echelons of maintenance by number designation. An X placed in the appropriate echelon column in line with an indicated maintenance function authorizes that echelon to perform the function. The X indicates the lowest echelon responsible for performing the function, but does not necessarily indicate repair parts stockage at that level. Higher echelons are authorized to perform the indicated functions of lower echelons.

*d. Remarks.* This column lists specific maintenance functions, special tools, cross-references, instructions, and the like pertinent to the operation being performed.

## Section II. MAINTENANCE ALLOCATION CHART

Functional group	Components and related operation	Echelons of maintenance					Remarks
		1	2	3	4	5	
01	ENGINE.						
0100	Engine Assembly.						
	Engine, diesel:						
	Service.....	X					
	Inspect.....	X					
	Test.....						
	Replace.....			X			Compression.
	Repair.....				X		
	Overhaul.....			X			
0101	Block, Cylinder Head.				X		
	Block; head, cylinder:						
	Replace.....				X		
	Repair.....				X		
0102	Crankshaft.				X		
	Crankshaft:						
	Replace.....				X		
	Repair.....					X	Metalize, Grinding, Alining.
	Bearings, main:						
	Replace.....				X		
	Damper:						
	Replace.....			X			
0103	Flywheel Assembly.						
	Flywheel assembly:						
	Replace.....				X		
	Repair.....				X		Replace ring gear.
	Housing:						
	Replace.....				X		
0104	Pistons, Connecting Rods.						
	Pistons; rings; pins; retainers; bearings:						
	Replace.....				X		
	Rods, connecting:						
	Replace.....				X		
	Repair.....				X		
0105	Valves, Camshaft and Timing System.						
	Valves; inserts:						
	Replace.....				X		
	Repair.....				X		
	Camshaft:						
	Replace.....				X		
	Timing gear:						
	Replace.....				X		
	Guide, valve:						
	Replace.....				X		
	Arms, rocker:						
	Adjust.....		X				
	Replace.....			X			
	Repair.....			X			
	Rods, push:						
	Replace.....			X			
	Cover, cylinder head:						
	Replace.....		X				
	Tappet assembly:						
	Replace.....				X		
	Repair.....				X		

Functional group	Components and related operation	Echelons of maintenance					Remarks
		1	2	3	4	5	
0106	Engine Lubrication System.						
	Pump, oil:						
	Replace.....				X		
	Repair.....				X		
	Filter, oil:						
	Service.....	X					
	Repair.....		X				
	Plunger, relief valve:						
	Replace.....		X				
	Spring, relief valve:						
	Replace.....		X				
	Oil cooler:						
	Repair.....		X				
	Pan, oil:						
	Replace.....				X		
	Breather:						
	Service.....	X					
	Replace.....		X				
	Cap, filler; dipstick:						
	Replace.....	X					
	Lines, fittings.....				X		Internal.
	Replace.....				X		External.
	Lines, fittings.....						
	Replace.....		X				
0108	Manifolds.						
	Manifold, exhaust:						
	Replace.....		X				
0109	Accessory Driving Mechanisms.						
	Pulley:						
	Replace.....			X			
	Support:						
	Replace.....			X			
03	FUEL SYSTEM.						
0301	Fuel Injector.						
	Injector, fuel:						
	Test.....			X			
	Replace.....			X			
	Repair.....			X			
0302	Fuel Pumps.						
	Pump, diesel:						
	Service.....	X					
	Test.....		X				
	Replace.....		X				
	Repair.....				X		
0304	Air Cleaner.						
	Cleaner, air:						
	Service.....	X					
	Repair.....		X				
0305	Turbocharger.						
	Turbocharger:				X		
	Repair.....				X		
	Manifold:						
	Replace.....		X				
	Hoses and clamps:						
	Replace.....		X				
	Aneroid control:						
	Repair.....		X				

Functional group	Components and related operation	Echelons of maintenance					Remarks
		1	2	3	4	5	
0306	Tanks, Lines, Fittings.						
	Tank, fuel:						
	Service.....	X					
	Inspect.....	X					
	Replace.....		X				
	Hoses and lines, fuel:						
	Replace.....		X				
	Cap, fuel tank:						
	Replace.....		X				
	Manifolds, fuel:						
	Replace.....			X			Chained.
0309	Fuel Filters.						
	Filters, fuel:						
	Service.....	X					
	Repair.....		X				
0311	Engine Starting Aids.						
	Aid, starting:						
	Service.....	X					
	Replace.....		X				
	Lines; fittings:						
	Replace.....		X				
0312	Accelerator, Throttle Controls.						
	Controls, accelerator and throttle:						
	Replace.....		X				
04	EXHAUST SYSTEM.						
0401	Pipes.						
	Pipes:						
	Replace.....		X				
05	COOLING SYSTEM.						
0501	Radiator.						
	Radiator:						
	Service.....	X					
	Inspect.....	X					
	Replace.....			X			
	Grille:						
	Replace.....		X				
	Cap:						
	Replace.....	X					
0503	Thermostats and Housing Gaskets.						
	Thermostat:						
	Test.....		X				
	Replace.....		X				
	Housing thermostat:						
	Replace.....		X				
	Hoses; clamps:						
	Replace.....		X				
	Pipes and fittings:						
	Replace.....		X				
0504	Water Pump.						
	Pump:						
	Service.....	X					
	Replace.....		X				
	Repair.....			X			
	Belt:						
	Adjust.....	X					
	Replace.....		X				
0505	Fan Assembly.						
	Hub assembly:						
	Repair.....			X			

Functional group	Components and related operation	Echelons of maintenance					Remarks
		1	2	3	4	5	
06 0601	Guard; fan:						
	Replace.....		X				
	Belt:						
	Adjust.....	X					
	Replace.....		X				
	ELECTRICAL SYSTEM.						
	Generator.						
	Generator:						
	Test.....		X				
	Replace.....		X				
	Repair.....			X			
	Brushes:						
	Replace.....		X				
	Belt:						
	Adjust.....	X					
	Replace.....		X				
	Generator Regulator.						
	Regulator, generator:						
	Adjust.....		X				
	Test.....		X				
	Replace.....		X				
0602	Starting Motor.						
	Motor, starting:						
	Service.....	X					
	Test.....		X				
	Replace.....		X				
	Repair.....			X			
	Brushes; solenoid:						
	Replace.....		X				
	Cables; wiring:						
	Repair.....		X				
0603	Instrument or Engine Control Panel.						
	Gages and meters:						
	Replace.....		X				
	Switches:						
	Replace.....		X				
	Light, panel:						
	Replace.....		X				
	Panels:						
	Replace.....		X				
	Miscellaneous Items.						
0607	Receptacle, slave:						
	Replace.....		X				
	Terminal, block:						
	Replace.....		X				
	Switch, stoplight:						
	Replace.....		X				
	Buzzer, air pressure:						
	Replace.....		X				
	Wiring:						
	Repair.....		X				
0608	Lamp, incandescent:						
	Replace.....	X					
	Lights.						
	Lights:						
	Replace.....		X				
	Lamps of lamp units:						
	Replace.....		X				
0609							



Functional group	Components and related operation	Echelons of maintenance					Remarks
		1	2	3	4	5	
0610	Gasket, door:						
	Replace.....		X				
0611	Sending Units and Warning Switches.						
	Sending units; switches:						
0612	Replace.....		X				
	Horn.						
0613	Switch; horn:						
	Repair.....		X				
0615	Wiring:						
	Repair.....		X				
0700	Batteries, Storage.						
	Batteries:						
0701	Service.....	X					
	Test.....		X				
0703	Replace.....		X				
	Cables:						
0708	Replace.....		X				
	Repair.....		X				
0721	Box, battery:						
	Replace.....		X				
0700	Chassis Wiring Harness.						
	Harness:						
0701	Repair.....		X				
	Radio Interference Suppression.						
0703	Capacitors:						
	Replace.....		X				
0708	Bonding strap:						
	Replace.....		X				
0721	TRANSMISSION.						
	Transmission Assembly.						
0701	Transmission:						
	Service.....	X					
0703	Inspect.....	X					
	Repair.....				X		
0708	Overhaul.....				X		
	Transmission Shafts.				X		
0721	Shafts, input and output:						
	Replace.....				X		
0703	Gears:						
	Replace.....				X		
0708	Bearings and oil seals:						
	Replace.....				X		
0721	Transmission Clutch and Clutch Controls.						
	Clutch assembly, forward and reverse:						
0708	Replace.....				X		
	Repair.....				X		
0721	Valve assembly, control:						
	Repair.....				X		
0708	Levers; linkage:						
	Replace.....		X				
0721	Torque Converter.						
	Torque converter:						
0708	Repair.....				X		
	Coolers, Pumps.						
0721	Cooler, oil:						
	Inspect.....	X					
0708	Repair.....		X				
	Pump, charging:						
0721	Replace.....		X				
	Repair.....		X				

Functional group	Components and related operation	Echelons of maintenance					Remarks
		1	2	3	4	5	
09	Filter, oil:						
	Service.....	X					
	Repair.....		X				
	Lines; fittings; hose:						
	Replace.....		X				
0900	Breather; sending unit:						
	Replace.....		X				
	PROPELLER SHAFTS.						
	Propeller Shafts.						
	Shafts, propeller:						
10	Service.....	X					
	Repair.....		X				
	FRONT AXLE.						
	Front Axle Assembly.						
	Axle, front:						
1000	Service.....	X					
	Inspect.....	X					
	Repair.....			X			
	Overhaul.....				X		
	Shaft, axle:						
1002	Replace.....			X			
	Differential.						
	Differential assembly:						
	Repair.....				X		
	Planetary Drive.						
1003	Drive, planetary:						
	Service.....	X					
	Replace.....			X			
	Repair.....			X			
	REAR AXLE.						
11	Rear Axle Assembly.						
	Axle, rear:						
	Service.....	X					
	Inspect.....	X					
	Repair.....				X		
1100	Overhaul.....				X		
	Shaft, axle:						
	Replace.....				X		
	Housing.						
	Housing, axle:						
1101	Replace.....				X		
	Differential.						
	Differential assembly:						
	Repair.....				X		
	Planetary Drive.						
1103	Drive, planetary:						
	Service.....	X					
	Replace.....			X			
	Repair.....			X			
	Steering.						
1104	Arm steering:						
	Replace.....				X		
	Knuckle, steering:						
	Service.....	X					
	Replace.....				X		
	Spindle:						
	Replace.....				X		
	Trunnion:						
	Replace.....				X		

Functional group	Components and related operation	Echelons of maintenance					Remarks
		1	2	3	4	5	
12	<b>BRAKES.</b>						
1201	Hand Brake.						
	Brake, hand:						
	Service.....	X					
	Adjust.....	X					
	Repair.....		X				
	Lever; linkage:						
	Replace.....		X				
1202	Service Brakes.						
	Brakes, service:						
	Replace.....			X			
	Repair.....			X			
1204	Hydraulic Brake System.						
	Power cluster:						
	Service.....	X					
	Repair.....		X				
	Cylinders, wheel:						
	Replace.....			X			
	Repair.....			X			
	Hose; lines; fittings:						
	Replace.....		X				
1208	Air Brake System.						
	Valve, treadle:						
	Replace.....		X				
	Repair.....			X			
	Lines; fittings:						
	Replace.....		X				
	Reservoir:						
	Service.....	X					
	Replace.....		X				
1209	Air Compressor Assembly.						
	Air compressor:						
	Service.....	X					
	Replace.....			X			
	Repair.....			X			
	Governor:						
	Replace.....		X				
	Repair.....		X				
1211	Trailer Brake Connections.						
	Coupling, dummy:						
	Replace.....		X				
	Lines; fittings:						
	Replace.....		X				
	Valve, hand control:						
	Replace.....		X				
	Repair.....			X			
13	<b>WHEELS.</b>						
1311	Wheel Assembly.						
	Wheels:						
	Replace.....		X				
	Drums:						
	Replace.....			X			
1313	Tires.						
	Tires:						
	Service.....	X					
	Replace.....		X				

Functional group	Components and related operation	Echelons of maintenance					Remarks
		1	2	3	4	5	
14	STEERING.						
1401	Steering Assembly.						
	Steering assembly.						
	Service.....	X					
	Inspect.....	X					
	Repair.....			X			
	Link, drag; rod, tie:						
	Replace.....		X				
	Wheel, steering:						
	Replace.....		X				
1411	Hose, Lines, Fittings.						
	Hose:						
	Replace.....		X				
	Repair.....		X				
	Lines; fittings:						
	Replace.....		X				
1412	Hydraulic Cylinders.						
	Cylinders:						
	Repair.....		X				
1414	Steering System Valves.						
	Valve, steering:						
	Replace.....			X			
	Repair.....			X			
	Valve, regulator:						
	Replace.....		X				
15	FRAME, TOWING ATTACHMENTS.						
1501	Frame Assembly.						
	Frame:						
	Replace.....				X		
1502	Counterweights.						
	Counterweight:						
	Replace.....		X				
1503	Towing Attachments.						
	Pin:						
	Replace.....		X				
18	HOOD.						
1801	Hood.						
	Hood; panels; covers:						
	Replace.....		X				
1805	Floors.						
	Floors; ladder:						
	Replace.....		X				
1806	Seats.						
	Seat:						
	Repair.....		X				
22	ACCESSORY ITEMS.						
2202	Accessory Items.						
	Accessory, items:						
	Replace.....		X				
2210	Data Plates.						
	Plates, data:						
	Replace.....			X			
	Plates, instruction:						
	Replace.....		X				
43	HYDRAULIC SYSTEM.						
4300	Hydraulic System.						
	Hydraulic system:						
	Service.....	X					
	Inspect.....	X					

Functional group	Components and related operation	Echelons of maintenance					Remarks
		1	2	3	4	5	
4301	Hose, Pipe Fittings.						
	Hose; fittings:						
	Replace .....		X				
4302	Pump.						
	Pump:						
	Replace .....		X				
	Repair .....			X			
4305	Manifold and/or Control Valves.						
	Valves:						
	Replace .....		X				
	Repair .....			X			
4307	Hydraulic Cylinders.						
	Cylinders, hydraulic:						
	Repair .....		X				
4308	Liquid Reservoirs.						
	Reservoir:						
	Repair .....		X				
	Breather:						
	Replace .....		X				
4309	Manual Controls.						
	Controls:						
	Replace .....		X				
47	GAGES: MEASURING DEVICES.						
4702	Gages.						
	Gages; lines; fittings:						
	Replace .....		X				
	Dipstick:						
	Replace .....	X					
50	PNEUMATIC EQUIPMENT.						
5001	Crankcase, Block Cylinder Head.						
	Crankcase; block:						
	Replace .....		X				
	Head, cylinder:						
	Repair .....		X				
5002	Crankshaft.						
	Crankshaft; bearings; seals:						
	Replace .....		X				
5004	Pistons, Connecting Rods.						
	Pistons; pins; retainers:						
	Replace .....		X				
	Rod, connecting:						
	Replace .....		X				
	Repair .....		X				
5005	Valves.						
	Valves; springs; retainers:						
	Replace .....		X				
5006	Lubrication System.						
	Lines:						
	Replace .....		X				
	Repair .....		X				
	Fittings:						
	Replace .....		X				
5008	Air Intake.						
	Intake, air:						
	Replace .....		X				
5009	Unloader System Components.						
	Pilot, unloader; valves:						
	Replace .....		X				

Functional group	Components and related operation	Echelons of maintenance					Remarks
		1	2	3	4	5	
5010	Compressor Cooling. Lines; fittings: Replace.....		X				
74	<b>EARTH MOVING EQUIPMENT COMPONENTS.</b>						
7436	Lift Arms and Pivot Assemblies. Booms; bellerank: Service..... Repair.....	X	X				
	Bushings: Replace.....			X			
7437	Loader Bucket Assembly. Bucket assembly: Service..... Repair.....	X	X				
	Indicator: Replace.....		X				
	Edges, cutting; teeth: Replace.....	X					
76	<b>FIRE FIGHTING EQUIPMENT.</b>						
7603	Fire Extinguisher. Extinguisher, fire: Service..... Replace.....	X	X				

## APPENDIX III

# BASIC ISSUE ITEMS LIST AND MAINTENANCE AND OPERATING SUPPLIES

### Section I. INTRODUCTION

#### 1. General

Section II lists the accessories, tools, and publications required in 1st echelon maintenance and operation, initially issued with, or authorized for the scoop type loader. Section III lists the maintenance and operating supplies required for initial operation.

#### 2. Explanation of Columns Contained in Section II

a. *Codes.* The information provided in each column is as follows:

- (1) *Materiel.* This column lists the basic materiel code number of the supply service assigned responsibility for the part. Blank spaces denote supply responsibility of the preparing agency. General Engineer supply parts are identified by the letters GE in parentheses, following the nomenclature in the description column. Other basic materiel code numbers are:
  - 3—Chemical Materiel
  - 9—Ordnance Materiel
  - 10—Quartermaster Materiel
  - 12—Adjutant General

- (2) *Source.* The selection status and source of supply for each part are indicated by one of the following code symbols:

- (a) P—applied to high-mortality repair parts which are stocked in or supplied from the supply service depot system, and authorized for use at indicated maintenance echelons.
- (b) P1—applied to repair parts which are low-mortality parts, stocked in or supplied from supply service depots, and authorized for installation at indicated maintenance echelons.
- (c) M—applied to repair parts which are not procured or stocked but are to be manufactured at indicated maintenance echelons.
- (d) X2—applied to repair parts which

are not stocked. The indicated maintenance echelon requiring such repair parts will attempt to obtain them through cannibalization; if not obtainable through cannibalization, such repair parts will be requisitioned with supporting justification through normal supply channels.

- (3) *Maintenance.* The lowest maintenance echelon authorized to use, stock, install, or manufacture the part is indicated by the following code symbol:

O—Organization Maintenance  
(1st and 2d echelon)

- (4) *Recoverability.* Repair parts and/or tool and equipment items that are recoverable are indicated by one of the following code symbols:

- (a) R—applied to repair parts and assemblies which are economically repairable at field maintenance facilities (3d and 4th echelons) and normally are furnished by supply on an exchange basis.
- (b) T—applied to high-dollar value recoverable repair parts which are subject to special handling and are issued on an exchange basis. Such repair parts normally are repaired or overhauled at depot maintenance facilities.
- (c) U—applied to repair parts specifically selected for salvage by reclamation units because of precious metal content, critical materials, high-dollar value reusable casing, castings, and the like.

*Note.* When no code is shown in the recoverability column the part is considered expendable.

b. *Federal Stock Number.* The Federal stock number will be shown in this column, and will be used for requisitioning purposes.

#### c. Description.

- (1) The item name and a brief description of the part are shown.



- (2) A five-digit Federal supply code for manufacturers and/or other supply services is shown in parentheses followed by the manufacturer's part number. This number will be used for requisitioning purposes when no Federal stock number is indicated in the Federal stock number column.

*Example:* (08645) 86453

- (3) The letters GE, shown in parentheses immediately following the description, indicates General Engineer supply responsibility for the part.

*d. Unit of Issue.* If no abbreviation is shown in this column, the unit of issue is each.

*e. Quantity Authorized.* This column lists the quantities of repair parts, accessories, tools, or publications authorized for issue to the equipment operator or crew as required.

*f. Quantity Issued with Equipment.* This column lists the quantities of repair parts, accessories, tools, or publications that are initially issued with each item of equipment. Those indicated by an asterisk are to be requisitioned through normal supply channels as required.

*g. Illustrations.* This column is subdivided into two columns which provide the following information:

- (1) *Figure number.* Provides the identifying number of the illustration.
- (2) *Item number.* Provides the referenced

number for the parts shown in the illustration.

### 3. Explanation of Columns Contained in Section III

*a. Item.* This column contains numerical sequenced item numbers, assigned to each component application, to facilitate reference.

*b. Component Application.* This column identifies the component application of each maintenance or operating supply item.

*c. Source of Supply.* This column lists the basic materiel code number of the supply service assigned responsibility for the item. Blank spaces denote supply responsibility of the preparing agency. Other basic materiel code numbers are—

9—Ordnance Materiel

10—Quartermaster Materiel

*d. Federal Stock Number.* The Federal stock number will be shown in this column and will be used for requisitioning purposes.

*e.* The item and brief description are shown.

*f. Quantity Required for Initial Operation.* This column lists the quantity of each maintenance or operating supply item required for initial operation of the equipment.

*g. Quantity Required for 8 Hours Operation.* Quantities listed represent the estimated requirements for an average 8 hours of operation.

*h. Notes.* This column contains informative notes keyed to data appearing in the preceding column.

## Section II. BASIC ISSUE ITEMS LIST

Source codes				Federal stock No.	Description	Unit of issue	Expendability	Quantity authorized	Quantity issued with equipment	Illustration	
Technical service	Source	Maintenance	Recoverability							Fig	Item
					GROUP 31. BASIC ISSUE ITEMS, MANUFACTURER INSTALLED						
					3100—BASIC ISSUE ITEMS, MANUFACTURER OR DEPOT INSTALLED						
9	P	O	-----	6140-057-2554	BATTERY, STORAGE: 12 volt, 6 cell (Repair Parts Manual Group 0612).	-----	-----	4	4		
	P	O	-----	7520-559-9618	CASE, MAINTENANCE AND OPERA- TIONAL MANUALS: cotton duck, water repellent, mildew resistant (GE).	-----	-----	1	1		
12			-----		DEPARTMENT OF THE ARMY LUBRI- CATION ORDER, LO 5-3805-201-15.	-----	-----	1	1		
12			-----		DEPARTMENT OF THE ARMY OPER- ATOR ORGANIZATIONAL FIELD AND DEPOT MAINTENANCE MAN- UAL, TM 5-3805-201-15.	-----	-----	2	2		
12			-----		DEPARTMENT OF THE ARMY OR- GANIZATIONAL FIELD AND DEPOT MAINTENANCE REPAIR PARTS AND SPECIAL TOOLS LIST, TM 5-3805-201-20P.	-----	-----	2	2		
	P1	O	-----	4210-893-1092	EXTINGUISHER FIRE: dry chemical; charged; hand; class 4-B, with universal bracket (GE).	-----	-----	1	1		
3	P	O	-----	6810-249-9354	SULFURIC ACID: electrolyte (Repair Parts Manual Group 0612).	gal	-----	7	7		
					GROUP 32. BASIC ISSUE ITEMS, TROOP INSTALLED						
					3200—BASIC ISSUE ITEMS, TROOP INSTALLED OR AUTHORIZED						
	P	O	-----	6240-155-7790	LAMP, INCANDESCENT: 28 volts, 21 candle power.	-----	-----	1	*		
	P1	O	-----	6230-268-9437	LIGHT, EXTENSION	-----	-----	1	*		
10	P	O	-----	4930-360-2801	GREASE GUN, HAND: lever operated	-----	-----	1	*		
10	P	O	-----	5120-224-4046	HAMMER HAND: machinist ball peen, 1 1/4 lb head.	-----	-----	1	*		
10	P	O	-----	4930-430-3264	NOZZLE ASSEMBLY, FLEXIBLE	-----	-----	1	*		
10	P	O	-----	4930-262-8868	OILER, HAND: 1 pt capacity	-----	-----	1	*		
10	P	O	-----	5120-223-7397	PLIERS, SLIP-JOINT: straight nose w/ cutter 8 in.	-----	-----	1	*		
10	P	O	-----	5120-223-0989	PUNCH, DRIVE PIN: solid 3/8 in. dia.	-----	-----	1	*		
10	P	O	-----	5120-227-7349	SCREWDRIVER, FLAT TIP: 3/8 in. wide, 11 1/4 in. lg.	-----	-----	1	*		
10	P	O	-----	5120-264-3794	WRENCH, OPEN END ADJUSTABLE: 1 1/8 in. opening, 12 in. lg.	-----	-----	1	*		
10	P	O	-----	5120-264-3793	WRENCH ADJUSTABLE AUTOMOBILE: 3 3/8 in. opening, 15 in. lg.	-----	-----	1	*		

# Section III. MAINTENANCE AND OPERATING SUPPLIES

Item	Component application	Source of supply	Federal stock No.	Description	Quantity required for initial operation	Quantity required for 8 hours operation	Notes
1.	0101 CRANKCASE (1).....	10	9150-265-9435	OIL LUBRICATING: 5 gal pail as follows: OE-30.....	19 qt	(3)	(1) Includes quantity of oil to fill engine oil system as follows: 19 qt crankcase.
		10	9150-231-6653	or 9250.....	19 qt	(3)	(2) See SM-C9100-SL for additional data and requisitioning procedure.
		10	9150-265-9428	OE-10.....	19 qt	(3)	(3) See current LO for grade application and replenishment intervals.
		10	9150-231-9037	or 9110.....	19 qt	(3)	(4) Tank capacity.
		10	9150-242-7603	OES.....	19 qt	(3)	(5) Average fuel consumption is 3 3/4 gal per hour of continuous operation.
2.	0306 FUEL TANK.....	10	9140-286-5294	FUEL OIL DIESEL: bulk as follows: Regular grade DF-2.....	55 gal (4)	(5)	(6) Quantity indicated is the minimum required for one start when temperature is below 40° F.
		10	9140-286-5286	Winter grade DF-1.....	55 gal (4)	(5)	(7) Radiator capacity.
		10	9140-286-5283	Arctic grade DF-A.....	55 gal (4)	(5)	(8) Use oil as prescribed in item 1.
3.	0311 ENGINE STARTING AID.....	10	2910-355-6377	CAPSULE, STARTING.....	1 (6)	(5)	(9) Includes quantity of gear lubricating oil as follows:
4.	0501 RADIATOR.....	9	6850-243-1992	WATER.....	32 qt (7)		22 1/2 qt front differential
				ANTIFREEZE: ethylene glycol 1-gal can.....	21 qt		20 1/2 qt rear differential
5.	0708 AND 0710 TRANSMISSION, CONVERTER, AND COOLER.....	9	6850-174-1806	ANTIFREEZE: arctic, 55-gal drum OIL, LUBRICATING: (8) OE 10.....	32 qt (7)	(3)	2 5/8 qt front planetary (ea)
				or 9110.....	21 qt	(3)	2 5/8 qt rear planetary (ea)
				OES.....	21 qt	(3)	1/4 qt steering gear
6.	1002 DIFFERENTIAL ASSEMBLY, FRONT (9).....	10	9150-577-5847	LUBRICATING OIL: gear, 5 gal pail as follows: GO 140.....	53 3/4 qt	(3)	(10) Use lubricating oil as prescribed in item 9.
		10	9150-577-5844	GO 90.....	53 3/4 qt	(3)	
		10	9150-257-5440	GOS.....	53 3/4 qt	(3)	
7.	1003 FRONT PLANETARY.....			LUBRICATING OIL: gear (9) GO 140.....	2 5/8 qt ea (10)	(3)	
				GO 90.....	2 5/8 qt ea (10)	(3)	
				GOS.....	2 5/8 qt ea (10)	(3)	
8.	1102 DIFFERENTIAL ASSEMBLY, REAR.....			LUBRICATING OIL: gear (9) GO 140.....	20 1/2 qt (10)	(3)	
				GO 90.....	20 1/2 qt (10)	(3)	
				GOS.....	20 1/2 qt (10)	(3)	
9.	1103 REAR PLANETARY.....			LUBRICATING OIL: gear (9) GO 140.....	2 5/8 qt ea (10)	(3)	
				GO 90.....	2 5/8 qt ea (10)	(3)	
				GOS.....	2 5/8 qt ea (10)	(3)	
10.	1204 HYDRAULIC BRAKE SYSTEM.....	10	9150-252-6375	HYDRAULIC FLUID: 1-gal can HBA.....	3/4 qt	(3)	

Item	Component application	Source of supply	Federal stock No.	Description	Quantity required for initial operation	Quantity required for 8 hours operation	Notes
11.	1401 STEERING GEAR (9)			LUBRICATING OIL: gear, 5-gal pail as follows: GO 140----- GO 90----- GOS-----	$\frac{1}{4}$ qt (10) $\frac{1}{4}$ qt (10) $\frac{1}{4}$ qt (10)	(3) (3) (3)	
12.	4308 HYDRAULIC SYSTEM			OIL LUBRICATING: 5-gal pail as follows: OE 10----- OES-----	58 qt (8) 58 qt (8)	(3) (3)	
13.	GREASE POINTS			GREASE AUTOMOTIVE AND ARTILLERY: 5-lb can as follows: GAA-----	5 lb	(3)	

# INDEX

	Paragraph	Page		Paragraph	Page
Air cleaner.....	128	58	Main frame.....	267	280
Air compressor.....	195, 253	123, 221	Rear wheel cylinder.....	262	257
Air compressor does not supply adequate pressure.....	108	55	Replacement of bucket teeth and cutting edge.....	268	281
Air governor.....	192	121	Rigid axle.....	265	270
Air pressure gage.....	21	14	Rigid axle (front) wheel brake assembly.....	259	253
Air reservoir.....	188	120	Steering axle.....	264	264
Air system:			Steering axle (rear) wheel brake assembly.....	261	256
Air compressor.....	253	221	Steering gear.....	263	257
Description.....	252	220	Torque converter and transmission.....	257	232
Hand brake valve.....	255	226	Torque converter charging pump.....	258	251
Power cluster.....	256	229	Turbocharger.....	269	281
Treadle valve.....	254	225			
Ammeter.....	16	14	Chassis assembly:		
Axle disengage lever.....	35, 173	18, 107	Battery box.....	180	111
Batteries.....	137	71	Counterweight.....	179	111
Battery box.....	180	111	Floorboards and ladder.....	181	112
Blackout headlight.....	143	78	General.....	176	109
Blackout stoplight.....	145	79	Grille.....	178	111
Boom.....	221	147	Hood and panels.....	182	112
Boom and bucket and accessory control levers.....	174	107	Hydraulic manifold enclosure.....	183	115
Boom control lever.....	34	17	Seat support.....	184	116
Boom cylinder.....	208, 248	136, 216	Wheels and tires.....	177	110
Boom descends with control valve in hold.....	117	56	Circuit breakers.....	138	72
Boom lever will not hold in position.....	114	56	Clam cylinders.....	250	218
Brake pedal.....	37	18	Cleaning and inspection of major sub-assemblies.....	228	157
Brake system:			Compressor passes excessive oil.....	110	56
Adjustments.....	186	118	Connecting rod and piston assemblies.....	234	163
Air compressor.....	195	123	Controls and instruments:		
Air governor.....	192	121	Air pressure gage.....	21	14
Air reservoir.....	188	120	Ammeter.....	16	14
Double check valve.....	189	120	Axle disengage lever.....	35, 173	18, 107
Emergency and service couplings.....	194	122	Boom and bucket and accessory control levers.....	174	107
General.....	185	117	Boom control lever.....	34	17
Handbrake valve.....	190	120	Brake pedal.....	37	18
Low pressure indicator.....	193	122	Bucket and accessory control lever.....	33	17
Parking brake.....	196	124	Bucket opening indicator.....	40	18
Safety valve.....	187	119	Bucket position indicator.....	32	17
Treadle valve.....	191	121	Directional shift lever.....	14	13
Brakes lock or drag after several applications.....	103	55	Drive lamp selector switch.....	26	16
Brakes will not apply.....	104	55	Engine oil pressure gage.....	17	14
Bucket assembly.....	219	144	Engine temperature gage.....	15	13
Bucket and accessory control lever.....	33	17	Foot throttle.....	38	18
Bucket and accessory control lever does not return to neutral.....	115	56	Foot throttle pedal and linkage.....	168	99
Bucket and boom:			Front floodlight switch.....	29	16
Boom.....	221	147	Fuel level indicator.....	41	18
Bucket assembly.....	219	144	General.....	10	13
Bucket position indicator.....	220	145	Hand brake valve.....	31	17
General.....	218	144	Hand throttle.....	169	102
Bucket cylinder.....	209, 249	137, 216	Hand throttle lever.....	39	18
Bucket opening indicator.....	40	18	Horn button.....	12	13
Bucket position indicator.....	32, 220	17, 145	Hourmeter.....	22	15
Bucket will not lift rated load.....	116	56	Ignition switch.....	23	15
Carrier repair instructions:			Instrument panel.....	170	102
Differential.....	266	273	Light and ignition control panel.....	171	103
Front wheel cylinder.....	260	255	Light control switch.....	25	16
			Low air pressure buzzer.....	42	19

	Paragraph	Page
Controls and Instruments—Continued		
Panel and park lamp selector switch.....	27	16
Parking brake lever.....	36, 175	18, 108
Range shift lever.....	13	13
Rear floodlight switch.....	30	16
Starter pushbutton.....	24	16
Steering wheel.....	11	13
Torque converter oil temperature gage.....	19	14
Torque converter temperature warn- ing lamp.....	20	16
Transmission clutch oil pressure gage.....	18	14
Transmission control levers.....	172	106
Unlock lever.....	28	16
Coolant temperature:		
Too high.....	82	52
Too low.....	81	52
Cooling system:		
Description.....	147	80
Fan and bracket.....	152	86
General.....	238	181
Radiator and converter oil cooler.....	151	85
Servicing the cooling system.....	148	81
Thermostat housing.....	149	83
Water pump.....	150, 241	84, 195
Correct air pressure but brakes won't apply.....	101	55
Counterweight.....	179	111
Crankcase breather.....	158	92
Crankcase sludge.....	78	52
Crankshaft.....	230	163
Cylinder head.....	235	171
Cylinder head cover.....	164	98
Cylinders chatter when in operation.....	121	56
Cylinders work slowly at rated engine rpm.....	113	56
Daily preventive maintenance services.....	59	45
Demolition:		
Explosives or weapons fire.....	272	287
General.....	270	286
Other methods.....	273	287
Render the loader inoperative.....	271	286
Training.....	274	287
Description and data:		
Description.....	3	4
Identification.....	4	5
Tabulated data.....	5	5
Detailed lubrication information.....	57	32
Differential.....	266	273
Directional shift lever.....	14	13
Double check valve.....	189	120
Drag link.....	200	128
Draining the steering hydraulic system.....	198	125
Draining the torque converter and trans- mission.....	211	138
Drive lamp selector switch.....	26	16
Drive shafts:		
General.....	215	141
Lower drive shaft.....	217	142
Upper drive shaft.....	216	141
Dusty or sandy areas.....	49	20
Electrical system:		
Batteries.....	137	71
Blackout stoplight.....	145	79
Blackout headlight.....	143	78

	Paragraph	Page
Circuit breakers.....	138	72
Description.....	136	71
Generator.....	139, 240	72, 194
Headlights and floodlights.....	142	77
Miscellaneous electrical components.....	146	79
Starting motor.....	141	77
Starting motor and solenoid switch.....	242	195
Tail and stoplight.....	144	79
Voltage regulator.....	140, 241	76, 195
Emergency and service couplings.....	194	122
Engine:		
Cylinder head cover.....	164	98
Exhaust manifolds.....	166	99
Exhaust pipe and fittings.....	162	95
General.....	161	94
Intake manifold.....	167	99
Turbocharger.....	163	95
Valve adjustment.....	165	98
Engine cannot reach governed rpm.....	68	51
Engine cylinder block.....	229	157
Engine dies.....	65	50
Engine disassembly into major subassem- blies.....	227	153
Engine fails to start or hard to start.....	62	50
Engine fuel knocks.....	69	51
Engine lubricating oil lines.....	159	93
Engine lubricating system:		
Crankcase breather.....	158	92
Engine lubricating oil lines.....	159	93
Engine oil cooler.....	156	90
General.....	153	87
Lubricating oil filter.....	155	89
Oil level gage, filler tube, and bracket.....	160	94
Pressure relief valve.....	157	92
Servicing the lubrication system.....	154	87
Engine misses or runs erratically.....	63	50
Engine oil cooler.....	156	90
Engine oil pressure gage.....	17	14
Engine overhaul:		
Cleaning and inspection of major subassemblies.....	228	157
Connecting rod and piston assemblies.....	231	163
Crankshaft.....	230	163
Cylinder head.....	235	171
Engine cylinder block.....	229	157
Engine disassembly into major sub- assemblies.....	227	156
Engine reassembly.....	236	174
Lubricating oil pump and suction tube assemblies.....	234	168
Preparing the engine for removal from the loader.....	224	151
Removal of accessories from the engine.....	226	152
Removing the engine and accessories from the loader.....	225	152
Rocker levers.....	232	165
Tappet assemblies.....	233	167
Engine reassembly.....	236	174
Engine running but loader will not move.....	88	53
Engine temperature gage.....	15	13
Erratic idle speeds.....	75	52
Excessive engine vibration.....	71	51

	Paragraph	Page		Paragraph	Page
Excessive foaming in hydraulic reservoir.....	120	56	Hissing at air intake tubing joints when engine is in operation.....	87	53
Excessive fuel consumption.....	73	51	Hood and panels.....	182	112
Excessive lubricating oil consumption.....	77	52	Horn button.....	12	13
Excessive noise in final drives.....	94	54	Hourmeter.....	22	15
Excessive noise when shifting from forward to reverse.....	93	54	Hydraulic control valve.....	207, 247	135, 212
Excessive pressure indicated on gage.....	107	55	Hydraulic manifold enclosure.....	183	115
Excessive smoke under load.....	67	51	Hydraulic pump.....	246	207
Excessive smoke when idling.....	66	50	Hydraulic reservoir.....	251	219
Excessive wear of bearings and journals.....	85	53	Hydraulic system:		
Excessive whine in the differential.....	92	54	Boom cylinders.....	248	216
Exhaust manifolds.....	166	99	Bucket cylinder.....	249	216
Exhaust pipe and fittings.....	162	95	Clam cylinders.....	250	218
Explosives or weapons fire.....	272	287	Description.....	245	206
Extreme cold (below 0° F.).....	47	28	Hydraulic pump.....	246	207
Extreme heat.....	48	28	Hydraulic control valve.....	247	212
			Hydraulic reservoir.....	251	219
Fan and bracket.....	152	86	Hydraulic system requires frequent bleeding.....	106	55
Filling the torque converter and transmission.....	212	138			
Fire extinguisher.....	53	30	Identification.....	4	5
Floorboards and ladder.....	181	112	Ignition switch.....	23	15
Foot throttle.....	38	18	Injector fuel connections.....	133	67
Foot throttle pedal and linkage.....	168	99	Injectors.....	134, 237	68, 178
Front wheel cylinder.....	258	251	Inspection and maintenance of equipment in storage.....	278	88
Fuel filter assembly.....	129	60	Inspection of equipment.....	8	10
Fuel level indicator.....	41	18	Instrument panel.....	170	102
Fuel pump.....	130, 238	63, 181	Intake manifold.....	167	99
Fuel shutoff valve.....	237	178			
Fuel supply and drain manifolds.....	132	66	Jerky steering.....	96	54
Fuel tank and lines.....	131	65			
Fuel system:			Leaks at steering cylinder.....	98	54
Air cleaner.....	128	58	Levers:		
Fuel filter assembly.....	129	60	Axle disengage.....	35, 173	18, 107
Fuel pump.....	130, 238	61, 171	Boom and bucket and accessory control.....	174	107
Fuel shutoff valve.....	237	178	Boom control.....	34	17
Fuel supply and drain manifolds.....	132	66	Boom lever will not hold in position.....	114	56
Fuel tank and lines.....	131	65	Bucket and accessory control does not return to neutral.....	115	56
General.....	127	58	Directional shift.....	14	13
Injector fuel connections.....	133	67	Hand throttle.....	39, 169	18, 102
Injectors.....	134, 237	68, 178	Parking brake.....	36, 175	18, 108
Primer discharger.....	135	69	Range shift.....	13	13
Full brake hydraulic pressure (1800 psi) cannot be developed.....	105	55	Transmission control.....	172	106
			Light and ignition control panel.....	171	103
Gages:			Light control switch.....	25	16
Air pressure gage.....	21	14	Loader moves slowly without sufficient power at wide open throttle.....	89	53
Engine oil pressure gage.....	17	14	Loader reaches rated power in one speed or direction but loses power in opposite speed or direction.....	90	54
Engine temperature gage.....	15	13	Low air pressure buzzer.....	42	19
Oil level gage, filler tube, and bracket.....	160	94	Low lubricating oil pressure.....	80	52
Transmission oil pressure gage.....	18	14	Low power or loss of power.....	64	50
General methods to attain proper suppression.....	125	58	Low pressure indicator.....	193	122
General sources of interference.....	124	57	Lower drive shaft.....	217	142
Generator.....	139, 242	72, 195	Lubricating oil:		
Grille.....	178	111	Filter.....	155	89
			Pump and suction tube assemblies.....	234	168
Handbrake valve.....	31, 253	17, 221	Too hot.....	83	52
Hand primer pump.....	40	18			
Hand throttle.....	169	102			
Hand throttle lever.....	39	18			
Headlights and floodlights.....	142	77			
High altitudes.....	51	29			



	Paragraph	Page		Paragraph	Page
Lubrication information.....	56	32	General methods to attain proper suppression.....	125	58
Lubrication oil dilution.....	79	52	General sources of interference.....	124	57
Main frame.....	267	280	Purpose.....	123	57
Main hydraulic pump.....	206	134	Replacement of components.....	126	58
Main hydraulic system:			Range shift lever.....	13	13
Boom cylinder.....	208	136	Rear wheel cylinder.....	262	257
Bucket cylinder.....	209	137	Record and report forms.....	2	4
General.....	203	132	Relief valve.....	202	130
Hydraulic control valve.....	207	135	Removal of the accessories from the engine.....	226	152
Main hydraulic pump.....	206	134	Removing the engine and accessories from the loader.....	235	171
Servicing the hydraulic reservoir.....	205	133	Replacement of bucket teeth and cutting edge.....	268	281
Servicing the main hydraulic system.....	204	132	Replacement of suppression components.....	126	58
Mechanical knocks.....	70	51	Rigid axle.....	265	270
Miscellaneous electrical components.....	146	79	Rigid axle (front) wheel brake assembly.....	259	253
Noisy compressor operation.....	109	55	Rocker levers.....	232	165
Oil level gage, filler tube, and bracket.....	160	94	Rough terrain.....	52	29
Operating details:			Safety valve.....	187	119
Operating details.....	45	19	Salt water or high humidity.....	50	29
Starting.....	43	19	Scope.....	1	3
Stopping.....	44	19	Seat and support.....	184	116
Towing trailer with loader.....	46	26	Service upon receipt of equipment:		
Operation of auxiliary material used in conjunction with the end item:			Inspection of equipment.....	8	10
Fire extinguisher.....	53	30	Servicing equipment.....	9	12
Primer discharger.....	54	30	Unloading equipment.....	6	10
Operation under unusual conditions:			Unpacking equipment.....	7	10
Dusty or sandy areas.....	49	29	Servicing the cooling system.....	148	81
Extreme cold (below 0° F.).....	47	28	Servicing the hydraulic reservoir.....	205	133
Extreme heat.....	48	28	Servicing the lubrication system.....	154	87
High altitudes.....	51	29	Servicing the main hydraulic system.....	204	132
Rough terrain.....	52	29	Shipment and storage:		
Salt water or high humidity.....	50	29	Inspection and maintenance of equipment in storage.....	278	288
Panel and park lamp selector switch.....	27	16	Loading equipment for shipment.....	276	288
Parking brake:			Preparing equipment for storage.....	277	288
Lever.....	36	18	Preparing equipment for shipment.....	275	287
Lever and linkage.....	175	108	Slow or hard steering.....	95	54
Lever will not operate.....	111	56	Starter pushbutton.....	24	16
Parking brake.....	196	124	Starting.....	43	19
Will not hold.....	112	56	Starting motor.....	141, 246	77, 207
Piston liner and ring wear.....	84	53	Steering axle (rear) wheel brake assembly.....	261, 264	256, 264
Piston rods leak at glands.....	119	56	Steering cylinder.....	201	129
Poor deceleration.....	74	52	Steering gear assembly.....	199, 263	124, 257
Power cluster.....	256	231	Steering surges or runs away.....	97	54
Preparing the engine for removal from the loader.....	224	151	Steering system:		
Preparing equipment for shipment.....	275	287	Drag link.....	200	128
Preparing equipment for storage.....	277	288	Draining the steering hydraulic system.....	198	125
Pressure relief valve.....	157	92	General.....	197	125
Preventive maintenance:			Relief valve.....	202	230
Daily preventive maintenance services.....	59	45	Steering cylinder.....	201	129
General.....	58	45	Steering gear assembly.....	199	125
Quarterly preventive maintenance services.....	60	45	Steering valve sticks.....	99	54
Primer discharger.....	54, 135	30, 69	Steering wheel.....	11	13
Quarterly preventive maintenance services.....	60	45	Steering wheel free play excessive.....	100	54
Radiator and converter oil cooler.....	151	85	Stopping.....	44	19
Radio interference suppression:			Stroke indicator pin on power cluster extends beyond two inches.....	102	55
Definition.....	122	57	Surging at governed speed.....	76	52

	Paragraph	Page
Tabulated data.....	5	5
Tail and stoplight.....	144	79
Tappet assemblies.....	233	167
Thermostat housing.....	149	83
Throttle has flat spot.....	72	51
Tools and equipment.....	55	32
Tools and lubricants:		
Detailed lubrication information.....	57	32
Lubrication information.....	56	32
Tools and equipment.....	55	32
Torque converter:		
Oil temperature gage.....	19	14
Temperature warning lamp.....	20	14
Torque converter and transmission.....	257	232
Torque converter and transmission hydraulic system:		
Draining the torque converter and transmission.....	211	138
Filling the torque converter and transmission.....	212	138
General.....	210	138
Torque converter and transmission oil filter.....	213	139
Torque converter charging pump.....	214-258	140, 251
Torque converter and transmission oil filter.....	213	139
Torque converter charging pump.....	214, 258	140, 251
Towing trailer with loader.....	46	26
Training.....	274	287
Transmission:		
Clutch oil pressure gage.....	18	14
Control levers.....	172	106
Oil overheating.....	91	54
Treadle valve.....	191, 254	121, 225
Troubleshooting:		
Air compressor does not supply adequate pressure.....	108	55
Boom descends with control valve in hold.....	117	57
Boom lever will not hold in position.....	114	56
Brakes lock or drag after several applications.....	103	55
Brakes will not apply.....	104	55
Bucket and accessory control lever does not return to neutral.....	115	56
Bucket will not lift rated load.....	116	56
Compressor passes excessive oil.....	110	56
Coolant temperature too high.....	82	52
Coolant temperature too low.....	81	52
Correct air pressure but brakes won't apply.....	101	55
Crankcase sludge.....	78	52
Cylinders chatter when in operation.....	121	56
Cylinders work slowly at rated engine rpm.....	113	56
Engine cannot reach governed rpm.....	68	51
Engine does.....	65	50
Engine fails to start or hard to start.....	62	50
Engine fuel knocks.....	69	51
Engine misses or runs erratically.....	63	50
Engine running but loader will not move.....	88	53

	Paragraph	Page
Erratic idle speeds.....	75	52
Excessive engine vibration.....	71	51
Excessive foaming in hydraulic reservoir.....	120	56
Excessive fuel consumption.....	73	51
Excessive lubricating oil consumption.....	77	52
Excessive noise in final drives.....	94	54
Excessive noise when shifting from forward to reverse.....	93	54
Excessive pressure indicated on gage.....	107	55
Excessive smoke under load.....	67	51
Excessive smoke when idling.....	66	51
Excessive wear of bearings and journals.....	85	53
Excessive whine in the differential.....	92	54
Full brake hydraulic pressure (1800 psi) cannot be developed.....	105	55
Hissing at air intake tubing joints when engine is in operation.....	87	53
Hydraulic system requires frequent bleeding.....	106	55
Jerky steering.....	96	54
Leaks at steering cylinder.....	96	54
Loader moves slowly without sufficient power at wide open throttle.....	89	53
Loader reaches rated power in one speed or direction, but loses power in opposite speed or direction.....	90	54
Low lubricating oil pressure.....	80	52
Low power or loss of power.....	64	50
Lubricating oil too hot.....	83	52
Lubrication oil dilution.....	79	52
Mechanical knocks.....	70	51
Noisy compressor operation.....	109	55
Parking brake lever will not operate.....	111	56
Parking brake will not hold.....	112	56
Piston liner and ring wear.....	84	53
Piston rods leak at glands.....	119	56
Poor deceleration.....	74	52
Slow or hard steering.....	95	54
Steering surges or runs away.....	97	54
Steering valve sticks.....	99	54
Steering wheel free play excessive.....	100	54
Stroke indicator pin on power cluster extends beyond two inches.....	102	55
Surging at governed speed.....	76	52
Throttle has flat spot.....	72	51
Transmission oil overheating.....	91	54
Valve spool leaks at seals.....	118	56
Worn valves and guides.....	86	53
Turbocharger.....	163, 269	95, 281
Unloading equipment.....	6	10
Unlock lever.....	28	16
Unpacking equipment.....	7	10
Upper drive shaft.....	216	141
Valve adjustment.....	165	96
Valve spool leaks at seals.....	118	56
Voltage regulator.....	140, 243	76, 196
Water pump.....	150, 241	84, 196
Wheels and tires.....	177	110
Worn valves and guides.....	86	53

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